Report of the Work of The Rubber Research Board in 1939.

(Established under the Rubber Research Ordinance (Chapter 302)).

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Report of the Work of The Rubber Research Board in 1939.

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The present report is the Ninth Annual Report of the Rubber Research Scheme (Ceylon) as constituted under the Rubber Research Ordinance (Chapter 302).

The provisions of the Ordinance are subject to the following amending Ordinances :—

No. 11 of 1934—Provides that raw rubber brought into the Island for the purpose of re-export shall not be liable for payment of the cess under the Rubber Research Ordinance.

No. 35 of 1935—Provides for transfer of the lease of Nivitigalakele to the Rubber Research Board.

No. 3 of 1936—Provides that the Board may apply for, purchase or otherwise acquire patents, brevets d'invention, concessions and the like.

CHAIRMAN'S REPORT

Board Membership.—The three-year period of office of the following nominated members of the Board terminated during the year and appointments to fill the vacancies were made as indicated below :—

Mr. J. C. Kelly, March 5th. Renominated for a further period of three years.

Mr. L. M. M. Dias, May 18th. Mr. T. Amarasuriya appointed.

Mr. J. L. D. Peiris, May 18th. Mr. T. C. A. de Soysa appointed.

Col. T. G. Jayewardena, V.D., June 26th. Mr. N. D. S. Silva, O.B.E., J.P., appointed.

Mr. R. C. Kannangara, M.S.C., June 26th. Renominated for a further period of three years.

Mr. F. H. Griffith, M.S.C., November 15th. Renominated for a further period of three years.

Mr. F. A. Obeyesekera, November 26th. Renominated for a further period of three years.

The following additional changes in the membership of the Board occurred during the year :—

Mr. R. P. Gaddum, M.S.C., resigned on January 10th and Mr. E. C. Villiers, M.S.C., was nominated in his place with effect from March 3rd.

Mr. F. H. Griffith, M.S.C., was on leave from April 1st to November 15th and Mr. L. E. Russell was nominated to act for him.

Mr. L. P. Gapp was on leave from April 1st to November 8th and Mr. A. W. Harrison was nominated to act for him.

Mr. C. A. Pereira retired from the Board owing to ill-health on April 7th, after having been a member since its inception. Mr. W. P. H. Dias, J.P., was nominated in his place with effect from June 9th.

The personnel of the Board at the end of 1939 was as follows :—

Ex-Officio Members.

The Acting Director of Agriculture, Mr. E. Rodrigo, C.C.S. (Chairman).

Representing the Financial Secretary—The Deputy Financial Secretary (Mr. C. H. Collins, C.C.S.).

Unofficial Members of the State Council nominated by H.E. the Governor.

Mr. G. E. de Silva, M.S.C.

Mr. R. C. Kannangara, M.S.C.

Mr. E. C. Villiers, M.S.C.

Members nominated by the Ceylon Estates Proprietary Association.

Mr. L. P. Gapp.

Mr. J. C. Kelly

Members nominated by the Planters' Association of Ceylon.

Mr. F. H. Griffith, M.S.C.

Mr. B. M. Selwyn.

Members nominated by the Rubber Growers' Association.

Mr. I. L. Cameron.

Mr. E. W. Whitelaw.

Members nominated by the Low-Country Products Association.

Mr. T. Amarasuriya.

Mr. L. B. de Mel, J.P., U.M.

Mr. T. C. A. de Soysa.

Mr. N. D. S. Silva, O.B.E., J.P.

Members nominated by H.E. the Governor to represent Smallholders.

Mr. W. P. H. Dias, J.P.

Mr. F. A. Obeyesekere.

Meetings.—Meetings of the Board were held at Colombo on January 17th, March 15th, July 3rd and October 12th and at Dartonfield on June 21st. The Board is again indebted to the Ceylon Chamber of Commerce for the use of its Committee Room for meetings held at Colombo.

Committees.—

Experimental Committee.—Mr. B. M. Selwyn succeeded Mr. F. H. Griffith, M.S.C., as Chairman. Mr. L. E. Russell acted for Mr. Griffith during the absence of the latter gentleman on leave. Mr. W. P. H. Dias, J.P., was appointed to the Committee in place of Col. T. G. Jayewardena, V.D. The personnel of the Committee at the end of the year was as follows :—

Mr. B. M. Selwyn.

Mr. W. P. H. Dias, J.P.

Mr. F. H. Griffith, M.S.C.

Mr. F. A. Obeyesekere.

The Director (Convenor).

Meetings of the Committee were held on February 28th, May 6th, July 31st, September 21st and November 28th.

Smallholdings Committee.—Mr. W. P. H. Dias, J.P., succeeded Mr. C. A. Pereira as a member of the Committee.

The personnel of the Committee at the end of the year was as follows :—

Mr. W. P. H. Dias, J.P.

Mr. F. A. Obeyesekere.

The Smallholdings Propaganda Officer.

The Director (Chairman and Convenor).

A meeting of the Committee was held in Colombo on September 23rd. The Committee inspected the work of the department in the Horana range on October 30th and the Kandy range on the afternoon of November 15th and morning of the 16th.

"*Ad hoc*" *Committees.*—A Committee consisting of Mr. C. H. Collins, C.C.S., and the Director made recommendations to the Board on the terms of service for locally recruited senior officers.

London Advisory Committee for Rubber Research (Ceylon and Malaya).—The Board continued to contribute jointly with the Rubber Research Institute of Malaya to the cost of research on the quality and utilisation of raw rubber carried out at the Imperial Institute, London, under the control of the London Advisory Committee for Rubber Research (Ceylon and Malaya). The Board's contribution during the year amounted to £875 which represents 25 per cent. of the total cost of the work.

The London Advisory Committee held meetings on 27th January, 28th April and 29th September. Meetings of the Technical Sub-Committee were held on the same dates.

FINANCE

Income.—The Board's main income was derived from the cess of 1/8 cent per pound levied on exports of rubber under Section 6 (1) (*a*) of the Rubber Research Ordinance. Income from this source considerably exceeded the estimate owing to the increase in the permissible exportable amount under the Rubber Regulation Ordinance in the latter part of the year. Monthly cess collections were as follows :—

January...	Rs.	17,913·78
February	,,	14,294·04
March ...	,,	13,312·66
April ...	,,	6,012·10
May ...	,,	7,543·07
June ...	,,	10,873·84
July ...	,,	13,565·95
August ...	,,	14,588·22
September	,,	17,472·66
October	,,	15,093·57
November	,,	12,544·85
December	,,	25,398·17
	Rs.	168,612·91

The Director submitted a memorandum in which it was proposed that the Board's income from cess collections should be stabilised at approximately Rs. 225,000 per annum by basing the cess on the basic quota under the Rubber Regulation Ordinance and varying the rate according to the permissible exportable amount. On the instructions of the Board the memorandum was circulated to the Ceylon Estates Proprietary Association, Low-Country Products Association of Ceylon, Planters' Association of Ceylon and the Rubber Growers' Association with a covering letter asking for their views and the proposal was still under consideration at the end of the year.

A profit of Rs. 27,537·13 was derived from the normal working of Dartonfield Estate and Rs. 11,899·66 from Nivitigalakele.

Expenditure.—Current expenditure amounted to Rs. 194,371·97, leaving a surplus for the year of Rs. 20,365·81. Capital expenditure amounted to Rs. 21,115·41, including the following items :—

Balance payments for buildings erected in 1938, Rs. 1,192 ; Field Laboratory at Nivitigalakele, Rs. 1,854 ; Junior Staff Bungalow at Dartonfield, Rs. 4,004; improvement of water supply, Rs. 701 ; replacement of steam boiler, Rs. 2,144 ; Laboratory Equipment, Rs. 4,602. A sum of Rs. 1,578 was expended on agricultural development at Dartonfield and Rs. 3,271 at Nivitigalakele.

Accounts.—The accounts of the Scheme have been audited by the Auditor-General and his report, together with a balance sheet and statement of income and expenditure, are attached.

TECHNICAL REPORTS

The reports of the Director, Chemist, Botanist and Mycologist, Soil Chemist, Smallholdings Propaganda Officer, Estate Superintendent and the London Advisory Committee for Rubber Research (Ceylon and Malaya) are also attached.

(Sgd.) E. RODRIGO,
Chairman of the Board,
Rubber Research Scheme (Ceylon).

8th February, 1940.

DIRECTOR'S REPORT FOR 1939

The enlargement of the scientific staff and the completion of the main building programme at Dartonfield during 1938 marked out 1939 as the first year of a period of development in the scientific work of the Rubber Research Scheme. Work was extended in various directions and it is extremely unfortunate that the outlook for the future has now become so obscure as the result of the outbreak of war. Up to the present there has been no serious interference with the Scheme's work and it is the policy of the Research Board to proceed with a normal programme of research as far as possible. It is, however, impossible to foretell what modifications may become necessary as the war progresses.

The present report follows the lines of previous annual reports. A summary of the year's activities is given below and more detailed accounts of the work are available in the departmental reports which are attached.

STAFF

Director.—Mr. T. E. H. O'Brien was in charge of the work of the Scheme during the year.

Chemical Department.—Mr. M. W. Philpott, Chemist, was away on military service during September.

Botanical Department.—Mr. R. K. S. Murray, Botanist and Mycologist, was away from the Island on special leave for three months from early July.

Dr. C. E. Ford, Geneticist, was away on military service during September.

Mr. C. A. de Silva, Assistant Botanist, was away on vacation leave for one month in November-December. His service contract was renewed for a period of four years.

Soils Department.—Dr. L. A. Whelan, Soil Chemist, was on duty during the year.

Smallholdings Department.—Mr. W. I. Pieris, Smallholdings Propaganda Officer, was away on special vacation leave for $3\frac{1}{2}$ months from early June. His service contract was renewed for a period of four years.

Estate and Experiment Station.—Mr. D. L. Nicol, Estate Superintendent, was in charge of Dartonfield Estate and Nivitigalakele Experiment Station during the year.

BUILDINGS

A field laboratory was constructed at Nivitigalakele for the use of the Geneticist.

Plans and estimates were prepared for the construction of an additional senior staff bungalow at Dartonfield, but the work was postponed owing to the outbreak of war. One junior staff bungalow was constructed at Dartonfield and one at Nivitigalakele.

CHEMICAL DEPARTMENT

Latex.—The present position of the latex export trade is that rubber growers in other countries appear to be taking steps to extend their facilities for production in order to meet the increased demand for concentrated latex which seems likely to develop during the next few years. In Ceylon, on the other hand, producers have taken little interest in the subject up to the present. The Research Scheme issued a planting memorandum during the year giving information regarding the market position, the nature of the plant required and costs of production, and the subject was also reviewed in the Quarterly Circular.

Several consignments of concentrated latex, both creamed and centrifuged, were shipped from Dartonfield to buyers in London and in India. The object of making the shipments is to demonstrate the methods of preservation and concentration and to maintain contact with the London and Indian markets.

A trial was undertaken to determine whether cement lined tanks can be used for the reception and storage of latex in place of the steel tanks commonly used, without affecting the stability or colour of the latex. There were no important differences in the properties of latex stored in a cement lined tank and in other forms of container for a period of three months.

Trials were made to test the claims that creaming can be improved by (*a*) the addition of soap to the latex, and (*b*) preliminary treatment in a colloid mill before creaming. Results recorded in the departmental report indicate that creaming was substantially improved by the addition of a small proportion of soap, either with or without the colloid mill treatment.

The latex separator was used for a series of trials under various conditions of feed and adjustment. The use of a special set of mid-plates with thinner abutments did not give any advantage which could not be obtained by using the normal mid-plates and limiting the rate of feed. It was found that the performance of the machine could be improved by preliminary treatment of the latex with small proportions of soap and a gum as specified in B.P. 490,871. The presence of such substances in centrifuged latex may, however, make it unsuitable for some uses.

A series of latex stability determinations was made using a modified form of the method in which the latex is stirred in the presence of zinc oxide. So far no seasonal variation has been found in the stability of Dartonfield latex and there was no abnormality in the stability of latex collected immediately after the resting period.

Variability of Raw Rubber.—Reference was made in the report for 1937 to the decision of the Board to undertake local investigations with a view to improving the uniformity of raw rubber. Work was held up during the greater part of 1938 owing to a defect in the vulcanising press and the programme was only started towards the end of that year. During 1939 attention was first directed towards the standardisation of testing methods and the investigations were afterwards mainly of an exploratory nature.

Monthly samples of smoked sheet and crepe from the four tapping divisions of Dartonfield were tested in the rubber-sulphur and standard accelerator mixings, with a view to determining the extent of seasonal variation on an estate where well-standardised methods of collection and preparation are employed. Variations during the first year of the experiment have been negligible.

Tests were made on samples of rubber collected from 30 estates. Twenty of them were selected because they produced rubber of abnormal properties when samples were examined in 1931 and for this reason the figures given in the departmental report cannot be regarded as an indication of the normal range of variation on local estates. Tests in the rubber-sulphur and accelerator mixings gave approximately parallel results.

Samples were examined from the tapping experiment area at Dartonfield on two occasions. Considerable variations were observed, but it will be necessary for further tests to be made before conclusions can be drawn from the data.

Tests were also made on monoclonal rubbers from Nivitigalakele and four other estates. All the young buddings were found to yield high-modulus fast-curing rubbers. The areas are still young and it cannot be said at present whether the properties are characteristic of the clones concerned or of young rubber in general.

Purified Rubber.—Considerable attention was given to experiments relating to the preparation of rubber with a high resistance to moisture absorption in view of the growing demand for material of this type for cable insulation and similar purposes. Moisture resistance depends on the removal of serum substances from the rubber and an investigation was undertaken to compare the relative effectiveness of a number of different methods of treatment. The work is discussed in detail in the departmental report and it will suffice in this summary to state that the most promising results have been obtained by multiple creaming and multiple centrifuging.

The only effective method of purification which could be adopted locally on a commercial scale at short notice would be the method of multiple creaming. This method is capable of yielding a product with reasonably good water-absorption properties at a cost of production not greatly in excess of that of normal crepe manufacture. Rubber prepared from twice creamed latex was forwarded to the London Advisory Committee for manufacturers' trials.

Various soaking treatments were applied to rubber prepared from creamed latex, but the improvement in moisture resistance was very slight. Attention was given to methods of incorporating antioxidants in the latex in view of the relatively poor ageing properties of purified rubber. A comparison was made of the relative efficiency of various creaming agents for primary and secondary creaming. Tragon seed gum (Tragon A) was found most suitable for primary creaming. Sodium alginate was equally useful for secondary creaming.

Rubber Coagulants.—On the outbreak of war an apparent shortage of formic and acetic acids developed on the local market and speculators made the most of the situation until maximum prices were fixed by Government. Local

stocks were normal at the time and the rush for supplies must be attributed to the desire of users to safeguard themselves against future shortage. During November a severe shortage of coagulants developed, particularly among small users, leading to the appearance on the market of a variety of substitute coagulants, mostly at exorbitant prices. Imports of acid during December were approximately normal and this tended to ease the situation. The Research Scheme received many requests for advice from all classes of producers and a considerable amount of time was given to the examination of alternative coagulants.

Reports from local importers regarding the prospects of an early resumption of normal supplies have from the first been reassuring and the general opinion is that adequate supplies will be available from alternative sources by February, 1940.

A planting memorandum on the subject of emergency coagulants was prepared early in September. Later, a communication on the same subject was issued to the English and Sinhalese press, and a more detailed article was published in the Quarterly Circular. Sulphuric acid was considered to be the only reasonably satisfactory substitute which was likely to be available in adequate quantities at short notice. Rubber producers were warned to be suspicious of proprietary substitutes of undeclared composition and to resume their normal procedure at the earliest possible opportunity in order to maintain the Island's reputation for producing good quality rubber.

Some trials were made on the use of sugar as an activator of spontaneous coagulation. Fairly complete coagulation can be obtained by this means, but crepe is off-colour and sheet contains many bubbles. Vulcanisation tests in the accelerated mixing showed that rubber prepared in this way is abnormally fast curing.

The possibility of preparing a satisfactory coagulant locally from the distillation products of coconut shells is being investigated by the Coconut Research Scheme in conjunction with the Department of Industries. Two samples of pyroligneous acid derived from this source were submitted for trial as coagulants. Vulcanisation and ageing tests on the rubber gave normal results and it was concluded that pyroligneous acid derived from coconut shells can safely be used as an emergency coagulant, provided it is produced under properly controlled conditions. It was advised that consideration of the advisability of erecting plant for the commercial production of the material should be postponed until it became clear whether adequate supplies of acid were likely to be available from outside sources during the continuance of the war.

Trials were undertaken on the re-use of serum as a means of reducing the quantity of acid required for coagulation, as suggested in a publication of the Rubber Research Institute of Malaya. The proportion of acid required to give moderately good coagulation was higher than that found necessary in Malaya and the completeness of coagulation varied from day to day. The difference in the results obtained here and in Malaya suggests that the value of the method may vary according to the character of the latex on different estates.

Coagulation trials were also made with mixtures of formic acid and calcium salts. Satisfactory coagulation was obtained with a dose of formic acid as low as 1 : 1,600 and the vulcanisation properties of the rubber were not substantially affected. This method of coagulation may merit further attention in the event of a prolonged curtailment of supplies of acid.

Estate Manufacture.—A series of trials was made with a continuous sheeting battery which had been installed at Dartonfield by the local agents during the previous year for trial and demonstration. A report on the machine was prepared towards the end of the year.

London Advisory Committee.—Close co-operation was maintained with the staff of the Committee at the Imperial Institute, London, especially in connection with the work on latex, purified rubber and variability.

We are again indebted to the Secretary of the Committee for his ready assistance in the purchase of chemicals and other equipment.

BOTANICAL AND MYCOLOGICAL DEPARTMENT

Oidium Leaf Disease.—It has been stated in previous reports that the incidence of Oidium in low-country districts is mainly dependent on the weather conditions which prevail during and before the refoliation and a new aspect of this relationship was revealed during the 1939 wintering season. Whereas severe attacks have previously been associated with dull, wet weather, on this occasion serious defoliation occurred on many low-country estates during a period of very dry weather. The explanation was considered to lie in the exceptionally low minimum temperatures experienced in January and February. The subject is further discussed in the report of the Botanist and Mycologist, and a report was also published in the Quarterly Circular.

Sulphur dusting was, in general, extremely successful in the Matale district. The results on some low-country estates, on the other hand, were disappointing. In certain cases the failure could be ascribed to faulty technique but in others it is difficult to suggest an explanation.

A trial was carried out on two mid-country estates to compare the efficiency of four brands of dusting sulphur. Two of the brands were standard products with 90-95% sulphur content and these gave the best results. One of the others had excellent cloud-forming properties which were associated with a high content of inert bituminous material and it is thought that a mixture of this grade with a purer sulphur might have special value.

As a preliminary to breeding work a search was started in the Matale district for estate trees which show a useful degree of resistance to Oidium over a period of years. Approximately 1,100 trees on two estates were marked as having a conspicuously heavy foliage during the year and 32 additional estates have agreed to make similar observations during 1940.

A proposal was approved by the Board early in 1940 for establishing a museum collection of high-yielding and promising clones in a mid-country area for the purpose of observing their resistance to Oidium.

The Board also considered the desirability of undertaking a systematic study f the histology of Oidium. A decision was reached in principle in favour of ne appointment of a special officer for the work, but it was agreed that funds ere not available for the purpose. The matter is still under consideration.

Root Diseases.—Cases of root disease continued to occur in replanted eas, mainly as the result of attacks by *Fomes lignosus* and *Poria hypobrunnea*. The aximum losses are usually in the second or third year from planting and the ouble is much reduced in later years. This is largely due to the eradication of ources of infection, but there are also indications that the fungus tends to relapse nto quiescence even where infected roots are left in the ground.

Estates with a high incidence of root disease in young areas were advised o undertake periodical examinations of the root systems of every plant in ccordance with the method developed by the Rubber Research Institute of Malaya. On one estate an experiment was undertaken to determine the value f the treatment under local conditions.

Die-back of Pueraria.—Die-back of covers of *Pueraria phaseoloides* under ature rubber was reported from a number of estates, particularly in the Kelani alley district. The subject has been investigated by the Botanist and Mycologist ho visited a number of the estates. In every case it was found that the cover d been growing for at least four years and the trouble appears so far as can e judged at present to be attributable to the condition known as " soil-sickness." elworms (*Heterodera marioni*) were almost universally present, but the degree f infestation was not usually sufficiently severe to suggest that it was the main ause of damage. The findings are discussed in greater detail in the departmental eport and suggestions for remedial measures are made along the lines of rotation f legumes, the encouragement of non-leguminous covers and the application f fertilisers containing phosphates.

Bird's-eye-spot (*Helminthosporium Heveae*).—As mentioned briefly in a otnote to the report for 1938 a substantial degree of control of Bird's-eye-spot as obtained by providing a light overhead shade in a seedling nursery at Nivitialakele. Satisfactory control was also obtained in the same nursery by spraying ith Perenox, a new copper fungicide.

Planting Material.—A selection of 29 mother trees was made from among everal hundred trees derived from seed from the Tjikadoe seed gardens in Java. lones from these and several other trees were established in a clone trial area f 10 acres which was planted at Nivitigalakele during the year. A census of he yields of individual trees at Dartonfield is being carried out and more accurate ecords will be kept in the case of any high-yielding trees.

An experiment was undertaken to compare various forms of treatment of udded stumps prior to and at the time of transplanting. The main conclusions om the experiment were that the removal of side roots appeared to have delayed prouting and retarded the rate of growth. Watering the plants with a dilute olution of Hortomone A may have slightly hastened sprouting, but had no ffect on the rate of growth of the plants. Other conclusions are discussed in the

departmental report. A further experiment was started to determine the extent to which the lateral roots may be cut and the value of immersion of the tap-root in Hortomone A before planting.

Arrangements were made to lease a small block of land on Mukalana estate on which high buddings of Tj.16 and B.D. 5 were made in 1931. The trees will be tapped on both stock and scion and data obtained on the effect of the yield of the stock on that of the scion. The Research Scheme is greatly indebted to the proprietors of the estate (Heirs of the late Mr. C. E. A. Dias) for giving facilities for the experiment to be carried out.

Test-tapping of Ceylon clones was continued at Nivitigalakele, Wagolla and on various estates co-operating with the Scheme. A report of the performance of the clones in 1938 was published in the Quarterly Circular. Yield figures for 1939 are not yet available and will be published later in the year. Figures relating to the commercial or semi-commercial test-tapping of imported clones are now being received from several estates in addition to test-tapping records of small groups of trees. Records for the year will be published when available.

The testing of certain of the local clones under trial at Nivitigalakele reached a stage at which it became desirable to provide facilities for the establishment of the clones in estate nurseries with a view to the rapid multiplication of any clone which was shown by further test-tapping to be suitable for commercial planting. The clones were developed from estate mother trees and it was necessary to come to an agreement with the owners of the estates regarding the respective rights of themselves and the Rubber Research Board in the material. As a result of discussions with the proprietors of the clones which are at present considered promising it was agreed that the following rights should be accorded to the Rubber Research Board :—

(*a*) To supply budwood to estates in Ceylon in quantities not exceeding five yards to any one estate, at the price of Rs. 15 per yard, subject to an undertaking being given by each proprietor that the material will not be redistributed. A royalty of 50 per cent. to be paid to the proprietors of the clone.

(*b*) To supply any quantity of budwood or budded stumps to persons eligible to purchase material through the Smallholdings Department of the Rubber Research Scheme (*i.e.* proprietors of less than 30 acres rubber) without disclosing the identity of the material. No royalty to be payable on such sales.

(*c*) To supply small quantities of budwood or budded stumps to Rubber Research Institutes in other countries for experimental purposes, subject to an undertaking being given that the material will not be re-distributed.

Budwood of the clones was multiplied in the nurseries at Nivitigalakele and material of three clones was supplied to a number of estates towards the end of the year. A standard form of sales agreement was prepared for signature by purchasers of the material. Budwood of seven clones was sent to the Rubber

esearch Institute of Malaya for experimental use and material of 10 clones eveloped in Malaya was received in exchange. Arrangements were also made or an exchange of clones with the Proefstation West Java and the Proefstation er A.V.R.O.S.

Breeding Investigations.—During the 1939 flowering season 2,565 artificial ollinations were made mostly between buddings of high yielding Ceylon clones. 08 fruits were harvested, representing 4·2% successes and 199 seedlings ere raised. The results are regarded as encouraging for the Geneticist's first eason's work in this direction and it is believed that the experience which has een gained will be of considerable value for future work.

Cytogenetics.—A satisfactory and relatively simple technique was developed or the study of nuclear division and approximate chromosome counts in root ips. Exact counts of the numbers of chromosomes are difficult owing to their ery small size, but it will be possible to distinguish with certainty between olyploids and the normal diploids. It is hoped that occasional certain counts ill be obtained. Certain difficulties arose in the study of nuclear reduction ivision in pollen grains, but it is hoped that these will be overcome when fresh owers are available.

Tapping.—The experiment on mature trees at Dartonfield in which eleven ifferent systems of tapping are being compared, completed its second year in ebruary, 1939, and the results for the first two years were published in the Quarterly Circular. The less intense systems of tapping gave little more than heir theoretical yield during the first year, but showed a relative increase in the econd year. A system which involves tapping the tree on alternate days but n alternating sides gave an increased yield which was just significant over the wo-year period. There were no significant differences in the rates of bark enewal.

An experiment was carried out on an estate, in consultation with the Research cheme, to determine the best means of " slaughter tapping " trees prior to eplanting. The trial mainly comprised a study of the yield on the " double-wo " system following after half-spiral alternate day and " double-three " apping. A yield 51% in excess of the control was obtained by " double-hree " tapping followed by deep tapping on the " double-two " system, during period of approximately one year.

Four tapping experiments in budded areas of imported clones on estates were started during the year; the clones involved being Tjirandji 1 and 16, Bodjong Datar 5 and A.V.R.O.S. 49. An interesting feature of the results to date is the relatively high yield obtained on a third spiral cut on alternate days.

A standard notation for tapping systems was devised by the Rubber Research nstitute of Malaya to provide a basis for describing tapping systems logically nd accurately. The proposed notation was discussed with research officers n Java, Sumatra and Ceylon and, in its final form, has been formally adopted by he research organisations in all four countries. Details of the notation were ublished in the Quarterly Circular.

Natural Covers.—The progress of the development of natural covers in the area of 20 acres at Dartonfield which was set aside for a study of the subject in 1936 is reviewed in the departmental report. The area was forked and manured in 1938 and belts down each row of trees were cut at ground level in 1938 and 1939. Woody erect plants were pruned in 1939. There has been a gradual change in plant associations including the replacement of grasses by more desirable types of vegetation. Comparison of yield figures suggests the possibility that a stage is being reached at which the improved type of vegetation is exercising a beneficial effect.

Replanting Experiments at Dartonfield

Area No. 1 (1934) has as its main object a comparison of the effects of four species of creeping cover on the development of the trees. After five years' growth the mean girth of the trees was 17·8 inches. The difference in the effects of the four covers was not significant, but the best growth was in the Vigna plots. Growth during the period 1938-1939 was significantly better in the Pueraria plots than in the other treatments. The covers of Pueraria and Centrosema remain thick and healthy but Vigna and Calopogonium have begun to thin out under the increasing shade.

Area No. 3 (1936) provides comparisons of three methods of opening the land, three methods of planting, and the effects of manuring with organic and inorganic mixtures. Measurements made after three years showed no significant difference between the growth on the contour platforms and in the trenches, but both were significantly better than the pitted drains. The stumped buddings had a mean girth of 11·8 inches and the increase for the year was slightly greater than that of the budded stumps.

A report on the progress of the trials was published in the Quarterly Circular.

SOILS DEPARTMENT

The Soils Department was formed on the arrival of the Soil Chemist, Dr. L. A. Whelan, in Ceylon towards the end of 1938. The work previously undertaken by the Botanical and Mycological Department was taken over and extended during 1939. Close co-operation between the two departments is necessary in many directions and, as recorded by the Soil Chemist in his report, the valuable practical knowledge of officers in the Botanical Department has been of great assistance to him during the year.

Manuring.—Knowledge of the fertiliser requirements of rubber under varying conditions is still very restricted and advice to estates for the present must be based on a combination of practical experience, general theoretical considerations and the results of experiments in this and other countries.

The general manuring treatment recommended for mature rubber is a biennial application consisting alternately of nitrogen and a mixture containing nitrogen, phosphoric acid and potash in the approximate proportions of 10 : $3\frac{1}{2}$: 2. Broadcasting of soluble fertilisers is recommended as a general procedure and the period immediately following refoliation is considered likely to be the best time of year for application.

The general recommendation for young replanted areas is to use progressively increasing quantities of mixtures containing nitrogen, phosphoric acid and potash in the approximate proportions of 2 : 2 : 1. Details of suitable mixtures are available in the form of a planting memorandum which was revised during the year.

As a result of the outbreak of war it became necessary to conserve local stocks of sulphate of ammonia, and an informal agreement was reached between the fertiliser distributors and representatives of agricultural interests whereby half the sulphate of ammonia in standard mixtures would be replaced by other nitrogenous ingredients. In advising on alternative mixtures offered by distributors the general policy has been followed of recommending the cheapest substitute mixture available at the time, subject to suitable safeguards being adopted in respect of the time and method of application.

Manuring Experiments.—The manuring experiment in mature rubber at Dartonfield completed the fourth year at the end of 1939. Results up to the end of 1938 covering a period of two years from the first application of manures were published in the Quarterly Circular and a summary is given in the departmental report. The yields of the manured plots except those treated with NP were significantly higher than the controls, the best results being obtained with an NPK mixture. The figures for 1939 have not yet been examined.

The manuring experiment in young replanted rubber at Dartonfield (Areas No. 2 and 2A) was restarted in June, 1938, and measurements of growth were made in March and September, 1939. As judged by height increments for the period of six months between the two sets of measurements there was a significant increase over the control for the treatments : PK, NPK and compost.

Replanting experiment No. 3 at Dartonfield includes a comparison of the effects of manuring with organic and inorganic fertiliser mixtures of equal nutrient content. Measurements made after three years' growth showed no difference in the effects of the two treatments.

An area of approximately two acres at Dartonfield which was replanted with budded stumps in May, 1939, was utilised for a small experiment to compare a soluble readily available manure with one less readily available, and to study the effect of the addition of small quantities of minor elements to the inorganic mixture. Measurements made three months after the first application of manures indicated a small but significant response to the organic mixture compared with the control and the other treatments. It is too early to draw conclusions from the experiment.

An experiment to compare the effects of compost manure with an artificial fertiliser mixture of corresponding nutrient content has been in progress since 1937 in an area at Nivitigalakele which was planted in 1935. Measurements made two years after the first application of the manures showed no difference between the treatments.

The clone trial area of 10 acres which was planted at Nivitigalakele in 1939 was utilised for a manuring experiment to study the effects of applying P, K, and

PK in the planting holes at the time of planting. The first series of measurements will be made shortly.

Manuring trials in young replanted areas were started on a number of estates in 1938 on lines recommended by the Research Scheme. Measurements for the first year were received from 12 estates and the response to manuring was significant in three instances. Responses may be expected to vary on different estates according to soil types and at this stage of the trials the results are also liable to be irregular owing to differences in pre-experimental manuring and other cultural operations.

A manuring experiment was undertaken in a seedling nursery at Nivitigalakele which was planted in July, 1938. Measurements of the plants at the age of 15 months showed a small but significant response to N and a small decrease due to P. Plants which had reached a suitable girth were then budded with a single clone. The percentage of successes was twice as high in plots which received N as on those from which N was omitted. Unfortunately the budding work was not randomised among the operators and the results cannot be examined statistically, but it is considered justifiable to conclude that the difference is a real one. Plants from certain of the plots have now been transplanted as budded stumps and observations will be made on the rate of sprouting and early growth.

Compost.—Several compost heaps were made during the year from waste green material without the addition of cowdung. The completeness of decomposition varied according to the amount of woody material present. Chemical analysis showed that the content of P and K was very low and it is considered important to recognise that compost prepared from this class of material cannot be regarded as a complete manure.

Soil Survey and Analysis.—Soil profiles were examined as opportunity occurred. Twenty-five profiles were examined and 160 soil samples collected for analysis. Laboratory work during the year involved 650 analytical determinations.

SMALLHOLDINGS DEPARTMENT

1939 was the first complete year in which the full staff of six rubber instructors was on duty and encouraging progress was made in the work of the department. The Smallholdings Propaganda Officer records that the Rubber Instructors are now recognised personalities among small rubber owners in most of the ranges. This is a good sign and it may be expected that the influence of the department will expand as the Instructors become better known among their constituents.

Very little tapping was done on smallholdings in the earlier part of the year when the price of uncouponed rubber in the provinces was as low as 4-6 cents per pound. From September onwards the price increased and reached a figure of 32-35 cents per pound in December. At the end of the year the majority of Smallholdings were being tapped and the increased output by this class of producer was helpful in enabling Ceylon to meet the increases in the export quota at short notice.

The outbreak of war led to a shortage of coagulants which was felt most keenly by small producers who normally obtain their requirements in small quantities and do not maintain reserves. During November in particular supplies of acetic and formic acid were virtually unobtainable in some areas, but the position eased somewhat in December owing to increased imports of acid. The subject of coagulants has already been discussed in another section of the report and it will suffice to say that the department gave advice to smallholders on the use of alternative coagulants on the basis of a communication to the press which was issued in English and Sinhalese.

The improved market conditions led to greater interest being taken in methods for the production of good quality sheet rubber and the construction of smokehouses. An inexpensive type of smokehouse had previously been designed by the department and a number of demonstration houses erected in the ranges. During the year further demonstration houses were erected and the construction of 83 additional houses was started by private owners under the Instructors' supervision. A handbill entitled "Dirt in Rubber" was prepared and arrangements were made through the courtesy of the Rubber Controller for a copy to be handed to every smallholder (involving a total distribution of 110,000 copies) with the first issue of rubber coupons in 1940. The handbill referred to consumers' complaints of the presence of dirt in raw rubber and gave short instructions for the preparation of clean sheet.

Increased interest was taken in the replanting of old rubber in the earlier part of the year, but after the improvement in prices, which was associated with a fall in the value of coupons, there was a very natural reluctance to remove any further trees while the market remains favourable for the sale of rubber. The Instructors gave assistance in replanting operations on a total of 128 holdings (174 acres), out of which planting was completed on 87 holdings (101 acres) during the year. In view of the campaign for the increased local production of foodstuffs encouragement was given to the growing of food crops on replanted areas, subject to suitable precautions to prevent undue competition with the main crop.

Supervision of new planting of rubber under the scheme for assisting such planting by middle class and peasant permit holders was under the control of the Chief Advisory Officer, New Rubber Planting Scheme, attached to the Land Commissioner's Department. A short course of training was given by the Smallholdings Propaganda Officer to the field staff of the Scheme, comprising 42 officers. Before the arrival of these officers in the districts the Rubber Instructors gave assistance in the lining and draining of 47 new planting blocks (134 acres) which had already been cleared.

The department continued to supply planting material to smallholders at a low price and approximately 17,000 budded stumps and 950 yards of budwood were issued. Considerably larger quantities were applied for and allocated, and much time was occupied in dealing with cancellations and postponements of delivery. This is a difficulty which is unavoidable in dealing with small owners who are not accustomed to planning their field programmes in advance.

The work of the Rubber Instructors consists essentially of demonstrational work in various directions. Reference has already been made to the demonstration smokehouses erected in the ranges. A demonstration replanted block of approximately half acre was also established in each of the ranges during 1937 and 1938. The upkeep of the areas has been supervised and the girth records given in the Smallholdings Propaganda Officer's report indicate that growth was satisfactory in four areas, whilst in three areas it was backward owing to the failure of the owners to weed properly in the early stages.

Seedling nurseries have also been established in the ranges for the purpose of budding instruction and demonstrations were started in 11 centres in two of the ranges. Half of each nursery is reserved for practice budding ; the other half is budded by the Instructor with approved material and the stumps are subsequently sold to applicants in the districts.

Demonstration compost pits were prepared and maintained in each range and smallholders encouraged to prepare their own pits. Approximately 120 new pits were opened by private owners during the year.

A competition was started in each range for the " best kept holding." The entrants were visited by the Instructors and advice given on the direction in which improvements should be effected. Judging will be undertaken in 1940 and marks allocated under various headings. The Director distributed prizes in respect of two competitions held in the Horana range in 1938. In addition to a substantial cash prize to the winner, useful utensils were given to the second and third competitors and certificates of merit to those who reached an approved standard. The certificates are much sought after, but it must be confessed that this is at least partly because the recipients hope they will be useful in helping them to obtain improvement assessments for their holdings.

Arrangements were made for printing a coloured poster advocating the replanting of poor areas with budgrafted rubber.

Demonstrations given by the Instructors during the year comprised 54 in sheet making, 83 in budding, 94 in tapping and marking the trees, 46 in disease treatment and 249 on miscellaneous subjects.

During the absence of the Smallholdings Propaganda Officer on leave the work of the department was supervised by Mr. C. A. de Silva, Assistant Botanist.

DARTONFIELD ESTATE

Crop for the year amounted to 64,500 lbs. representing a shortfall of 7,500 lbs. on the estimate and a reduction in the yield per acre from 584 lbs. to 542 lbs. compared with last year. The decline is attributed partly to weather conditions which included a severe drought early in the year and unseasonable rain in the later months, and partly to the effects of Oidium. It is also probable that the yielding capacity of the estate is rather lower than it was a few years ago when the rubber had benefitted from several years intermittent tapping prior to the date of purchase by the Research Board. The proportionate drop in yield was approximately equal in the three main fields of the estate planted in 1910, 1913 and 1917 respectively.

Approximately half the crop was marketed in the form of crepe. Latex shipments amounted to 6½ tons (rubber) and the remainder consisted of smoked sheet and scrap crepe.

There were two exceptional rainstorms during the year; one of 13·7 inches in May and one of 21 inches in August. On the latter occasion minor overflows occurred in the two-acre replanted area and some damage was done to the estate roads.

The attack of Oidium leaf disease was the worst so far experienced on the estate. Moderately good control was obtained by sulphur dusting but leaf-fall was relatively heavy in the upper part of the estate. Three cases of root disease were reported in the mature fields and seven cases in replanted areas. Phytophthora leaf-fall was almost completely absent.

Half the estate was manured with an inorganic mixture in accordance with the programme of biennial applications. Manuring of replanted areas was carried out according to experimental requirements. A satisfactory ground cover of Pueraria has now been established almost throughout the estate. The cover was beaten down in areas where its growth was unduly heavy.

Replanting was undertaken in an area of two acres which lies between the blocks replanted in 1936 and 1938. The method of opening was a modified trench system which may prove useful for areas where a high planting density is to be adopted. The clearing was planted with budded stumps of eight imported clones which had not previously been planted out.

The Visiting Agent, Mr. P. R. May, inspected the estate on 27th January, 16th May, and 24th November. His reports were all satisfactory.

NIVITIGALAKELE

Crop for the year amounted to 20,200 lbs. and the shortfall compared with the estimate was of the same order as at Dartonfield. The average yield for the tapped areas was 420 lbs. per acre. Approximately 70% of the crop was marketed as smoked sheet and the remainder as scrap crepe, mainly derived from test-tapping biscuits.

Oidium leaf disease was more severe than in previous years and four rounds of sulphur dusting were carried out. Wind damage accounted for the loss of 9 trees. One case of root disease occurred in the 1935 clearing.

Manuring in the 1926, 1927 and 1928 clearings was carried out on the basis of an annual application of an inorganic mixture. Two applications were made in the 1935 (Pinnagoda) clearing. Nurseries were manured according to requirements. Rooted cuttings of *Desmodium ovalifolium* were planted in the 1926 clearing in which it has proved impracticable to establish Pueraria.

Growth in the 1935 Pinnagoda area is still backward, but measurements made during the year showed a considerable improvement in the rate of growth compared with the previous year. The average girth of budded stumps in the area at four years was 10·0 inches.

An area of 10 acres of jungle was cleared and planted for a clone trial. The block of land is very steep and careful attention to soil conservation measures was necessary to prevent losses by erosion. Silt pitted drains at a gradient of 1 : 120 were opened at intervals of 20 feet. Stone terraces were constructed in rocky areas and stones excavated from the drains were built into rough terraces above the drains. The drainage system was severely tested during severe storms in May and August and remarkably little damage was done.

An area of three acres was cleared towards the end of the year for temporary use for the cultivation of food crops and for subsequent use as a seedling nursery. Work was also started on an area of 10 acres which is to be cleared without burning for planting as a clone trial area in 1940.

Fourteen courses of training in budgrafting were held during the year. They were attended by 155 students, most of whom attained a useful standard of proficiency.

WAGOLLA

A crop of 2,088 lbs. was obtained from the 197 trees in tapping. The crop was in the form of test-tapping samples which were re-milled at Dartonfield.

Monthly supervising visits were made by the Nivitigalakele Conductor and the Estate Superintendent inspected the area on two occasions.

ADVISORY SERVICES, ETC.

The decision to allow new planting of rubber in Ceylon during the period 1939-1940 to the extent of 30,260 acres led to an extensive demand for information on planting methods and material. Government established an organisation known as the " New Rubber Planting Scheme," under the control of Mr. W. C. Lester Smith, as Chief Advisory Officer, to give advice and assistance to peasant and middle-class holders of permits for new planting. The Rubber Research Scheme undertook to give advice to capitalist permit holders irrespective of whether, as owners of existing rubber, they were contributors to the funds of the Scheme through the export cess.

At the request of Government a manual of instruction on new planting was prepared by the Botanist and Mycologist for issue by Government. The first part of the manual dealing with first year operations was completed in January and the second part dealing with later operations, in June. It is unfortunate that the manual has not yet been published, but it has proved of considerable value as a basis for advisory work on new planting during the year.

Advice was given to the Department of Agriculture on the upkeep and budding of the budwood multiplication nurseries opened last year to provide material for new planting and approximately 2,700 yards of budwood were supplied for use in the nurseries. In collaboration with the Chief Advisory Officer a schedule of measures for the prevention of soil erosion was prepared for issue under the regulations of the Rubber (New Planting) Ordinance.

The total volume of enquiries on agricultural subjects was smaller than last year. The largest number was in connection with planting material and there

vere also enquiries on replanting procedure, cover crops, Oidium leaf disease nd manuring. The curtailment of supplies of sulphate of ammonia after the utbreak of war led to a series of enquiries regarding substitute manure mixtures.

Mycological specimens were referred to the Plant Pathologist of the Department of Agriculture, for report during the absence of the Botanist and Mycologist n leave. The Research Scheme is indebted to Mr. M. Park and Mr. L. S. Bertus or their effective co-operation during the period.

The subject of rubber replanting in relation to malaria was discussed with he medical officer of the Malaria Control Scheme. It was agreed that there vas no essential incompatibility between the requirements of malaria control nd agricultural efficiency. Subsequently a joint leaflet was issued explaining ow these requirements can be reconciled.

On the chemical side the improved selling price of rubber led to increased nterest being taken in the improvement of factory equipment. Advice was iven on the equipment of a large crepe factory and 24 smokehouse plans were sued during the year. A type plan was prepared of a warm air drying house or crepe, suitable for a daily output of 2,000 lbs. The shortage of coagulants fter the outbreak of war resulted in many enquiries on the subject of alternative oagulants.

A circular letter was issued to local agency firms drawing attention to the mportance of improving the cleanliness of plantation rubber and advocating, n particular, the provision of latex settling tanks on all estates. Enquiries eceived towards the end of the year indicated that there is likely to be a good esponse to the circular. Considerable progress appears to have been made n the adoption on estates of Monel and nickel gauze for straining the latex, in lace of brass gauze.

The preparation of a series of " Planting Memoranda " to facilitate advisory ork was started in 1937. The series was extended during the year and several f the memoranda were revised. Copies of all new and revised memoranda are upplied to Agency firms and to a number of Visiting Agents and copies are ent to Estate Superintendents on request. Suggestions have been made from everal quarters that the memoranda should be issued to all estates on the publications register and the suggestion is at present under consideration. The emoranda at present available are as follows :—

No. 1—Notes on Budgrafting Procedure.

No. 2—Programme of Manuring for Replanted Rubber Clearings.

No. 3—Notes on Rubber Seedling Nurseries.

No. 4—Contour lining, holing and filling, cutting of platforms, trenches and drains.

No. 5—Straining box for latex.

No. 6—Notes on the care of Budded Trees of Clone Tjirandji 1 with special reference to Wind Damage.

No. 7—Notes on Dartonfield Estate, Factory procedure and equipment.

No. 8—Planting and after-care of budded stumps.

No. 9—Preparation of latex for shipment.

No. 10—Root disease in replanted areas.

No. 11—Emergency Rubber Coagulants.

No. 13—Notes on the preparation of clean rubber.

Advice was given to the Department of Industries in connection with the establishment of a State Rubber Factory and the possibility of local manufacture of acetic acid.

Advisory visits were made to estates during the year as follows :—

Botanical and Mycological Department	41
Soils Department	8
Chemical Department	3

There were 112 visitors to Dartonfield during the year according to the Visitors' Book which usually does not provide a complete record. In addition a party of 17 students from the Farm School, Peradeniya, visited the estate. Among notable visitors were Sir John Russell, Director, Rothamsted Experimental Station ; The Hon'ble Mr. G. C. S. Corea, Minister for Labour, Industry and Commerce, and Mrs. Corea ; Mr. R. J. Chittenden, Agriculturist to the Prang Besar Company ; Mr. W. O. Stevens, C.C.S., Government Agent, Western Province ; Dr. P. J. S. Cramer.

MEETINGS, COMMITTEES, ETC.

The Director attended meetings of the Rubber Research Board by invitation and served on the Experimental Committee and the Smallholdings Committee.

The Director is an ex-officio member of the Central Board of Agriculture and also served as an acting member of the Rubber Advisory Board for the greater part of the year.

The Director attended the annual general meeting of the Planters' Association of Ceylon and the general meetings of the Kalutara Planters' Association.

The Director, Soil Chemist and Botanist and Mycologist attended the biennial conference of the Tea Research Institute.

The Botanist and Mycologist addressed the Matale Planters' Association on the subject of Oidium leaf disease. There were no other requests from District Planters' Associations for lectures, probably because subjects of current interest had been ventilated at the Rubber Conference late in 1938 and there was a prospect of a similar conference being held in 1939. The Planters' Association of Ceylon arranged to hold a Rubber Conference in November but, owing to the outbreak of war, it was postponed until April, 1940.

CO-OPERATION WITH OTHER RESEARCH ORGANISATIONS

Mr. H. J. Page, Director, Rubber Research Institute of Malaya, spent four days in Ceylon early in July. He attended a special meeting of the Rubber Research Board and gave an account of the arrangements which had been made

for ensuring effective co-operation between the British Rubber Producers' Research Association, the London Advisory Committee for Rubber Research (Ceylon and Malaya) and the Rubber Research Institute of Malaya. Oidium leaf disease and other subjects of interest were also discussed. Mr. E. R. Guest, Botanist, Rubber Research Institute of Malaya, also visited the station.

As in previous years there was a regular exchange of reports with the Rubber Research Institute of Malaya and close co-operation was maintained by correspondence between the officers of the two Institutes. Reports were also exchanged with the Rubber Growers' Association. The Board of the British Rubber Producers' Research Association invited the Research Board to co-operate closely with the Association and this policy was cordially endorsed.

An exchange of promising local clones was effected with the Rubber Research Institute of Malaya and arrangements for an exchange of material were made with the Proefstation West Java and the Proefstation der A.V.R.O.S. We are indebted to the Rubber Research Institute of Malaya and the Proefstation West Java for supplying type seeds of a number of clones at our request.

Co-operation is maintained with the Tea Research Institute and the Coconut Research Scheme on subjects of mutual interest.

Publications were exchanged with a number of scientific organisations in different parts of the world.

PUBLICATIONS

Publications of the Research Scheme are issued without charge to the Proprietors (resident in Ceylon), Superintendents and Local Agents of rubber estates over 10 acres in extent, who apply for registration. Extra copies are supplied for the use of Assistants on large estates. It was decided that publications should also be available, on request, to holders of permits to plant rubber to the extent of more than 10 acres. There were 735 estates and agencies on the register at the end of the year, together with 51 subscribers who were not eligible for free issues.

Publications issued during the year were as follows :—

Report of the work of the Rubber Research Board in 1938.

1st Quarterly Circular, 1939—

Ceylon Clones—VII (1938). C. E. Ford.

Field Experiments on Dartonfield Estate—VIII. Manuring Experiment with Mature Rubber (1938). L. A. Whelan and C. A. de Silva.

Planting Notes.

The Quality of Plantation Rubber. T. E. H. O'Brien.

2nd Quarterly Circular, 1939—

Field Experiments on Dartonfield Estate—IX. Comparison of Tapping Systems. R. K. S. Murray and C. A. de Silva.

The Performance of Imported Clones in Ceylon—III. C. E. Ford.

Oidium Leaf Disease in Ceylon in 1939. R. K. S. Murray.

Identification of Clones on Ceylon Estates. R. K. S. Murray.

Combined 3rd and 4th Quarterly Circular, 1939—

Field Experiments on Dartonfield Estate—X. Measurements of Growth in Replanted Areas, 1939. L. A. Whelan and C. A. de Silva.

A Standard International Notation for Systems of Tapping Hevea.

War-time Supply of Coagulants. T. E. H. O'Brien.

Latex Shipment. M. W. Philpott.

Leaflet No. 17—

Rubber replanting in relation to Malaria.

A communication entitled " Emergency Rubber Coagulants " was issued to the English and Sinhalese press.

(Sgd.) T. E. H. O'BRIEN,
Director.

Research Laboratories,
Dartonfield,
Agalawatta,
31st January, 1940.

REPORT OF THE CHEMIST FOR 1939

STAFF AND ORGANISATION

The Chemist, Mr. M. W. Philpott, was in charge of the work of the Department during the whole of 1939 but was absent for one month on military duty.

The appointment of an additional assistant, Mr. V. K. Viswanathan, enabled Mr. N. Palewandrem, Laboratory Assistant, to devote his whole-time to the physical testing of rubber : an arrangement which was necessitated by the development of investigations on the variability and purification of raw rubber.

LATEX

Latex Shipment.—In those countries farther east where an export trade in latex has already been built up, rubber growers are reported to have been taking steps during 1939 to extend their means of production in order to meet the increased demand for concentrated latex that seems likely to develop during the next few years. In Ceylon there has been no such activity ; one or two requests for information have been addressed to the Research Scheme, but little real interest has been shown. This conservatism on the part of Ceylon producers would be more easily accounted for if the demand for latex were problematical or if the technique of production were not well understood. But not only has consumption increased steadily during the last fifteen years, but latex has been produced at Dartonfield and shipped commercially since 1935. In the light of the experience so gained it can be concluded that there are no uncontrollable factors which would militate against the successful production of latex on Ceylon estates. In two respects indeed local producers might well have considered themselves to be in a favourable position for entering the latex market. Firstly, the main concentration patents expired in Ceylon in 1937 and 1938 at a time when they were still in force in Malaya and the Dutch East Indies ; and secondly, Ceylon is specially well situated to supply the new but growing Indian market.

Early in the year a Research Scheme memorandum was prepared for the information of estates in which details were given of the market position, the nature of the plant required and the costs of production. The subject was also reviewed in the Combined 3rd and 4th Quarterly Circular published in December, 1939.

As in previous years latex was prepared for shipment at Dartonfield Estate and a number of consignments of concentrated latex, both creamed and centrifuged were shipped to buyers in London and in India. The objects of making these commercial shipments were to demonstrate the processes of preservation and concentration, and to maintain contact with the London and Indian markets.

Experimental work on latex production was confined mainly to the study of concentration processes (see next section). But one trial which was undertaken in connection with the storage of freshly ammoniated latex should be recorded because it established a point of some practical interest to potential latex producers. Tanks for the reception, bulking and storage of preserved latex are usually constructed of iron or steel painted internally with a chemically resistant protective coating. The comparatively high cost of steel tanks, particularly in war time, raises the question whether reinforced concrete tanks might not be equally suitable. In order to determine the influence of cement concrete on stability and colour, a small covered tank was built and filled with freshly preserved normal ammoniated latex. For comparison the same latex was stored in (1) glass bottles, (2) a kerosene tin filmed with rubber, (3) a 45-gallon iron drum painted internally with a chemically resistant paint. Samples were removed at intervals up to 105 days and tested for stability and colour, but no differences of any importance were observed. Except where it is structurally impracticable therefore the provision of concrete tanks for preserved latex installations may be provisionally approved. Arrangements are being made to instal a 600-gallon concrete storage tank at Dartonfield.

Latex Concentration.—In the present absence of any latex producing interests in Ceylon it would be hardly justifiable for the Research Scheme to devote more of its time to this subject than is necessary in order to form an estimate of the potential value to Ceylon of technical improvements made in other countries. Attention was therefore confined to the basic creaming and centrifuging processes and to the local application of certain new developments in technique.

(*a*) *Concentration by Creaming.*—A number of trials were made with the object of testing the claims that creaming is facilitated by (*a*) adding soap to the latex, and (*b*) violent agitation of the latex before creaming. The agitation of the latex was secured by passing the creaming mixture through a laboratory size Premier paste mill. Several series of creaming trials are summarised in Table I. In all cases creaming capacity was improved by the addition of soap and by passing the creaming mixture through the colloid mill. The effects did not appear to be specific to any type of latex or to any particular creaming agent, and the milling treatment was relatively more effective in the presence than in the absence of soap.

Trials were also made to test the capacity of other surface active materials (wetting agents, etc.) to assist creaming. A number of substances (Igepon T, Lissapol C, etc.) were found to be more effective than ordinary soap but their practical utility was limited by their higher cost.

For Dartonfield latex it may be concluded that the addition of soap to the latex, either with or without a preliminary colloid mill treatment, affords a simple and practical means of improving creaming efficiency.

Creaming experiments were also carried out in connection with purified rubber and are recorded under that heading.

TABLE I

No.	Age	Latex		Creaming Agent	Soap	Milling Treatment	Cream D.R.C. %
		D.R.C.	NH_3	% on liquid phase	% on latex		
	Days	%	%				
A.1	5	39·7	·77	Tragon A : 0·3	None	None	59·1
A.2	5	39·7	·77	do.	do.	Once through mill	59·2
A.3	5	39·7	·77	do.	do.	Three times through mill	59·3
A.4	5	39·7	·77	do.	0·3	None	60·2
A.5	5	39·7	·77	do.	0·3	Once through mill	61·6
A.6	5	39·7	·77	do.	0·3	Three times through mill	63·5
B.1	0	—	—	Tragon A : 0·3	None	None	50·6
B.2	0	—	—	do.	0·3	do.	57·3
C.1	1	—	—	do.	None	do.	55·5
C.2	1	—	—	do.	0·3	do.	59·9
D.1	5	—	—	do.	None	do.	59·1
D.2	5	—	—	do.	0·3	do.	60·2
E.1	12	—	—	do.	None	do.	58·6
E.2	12	—	—	do.	0·3	do.	60·5
F.1	1	39·0	·70	Tragon A : 0·3	0·3	None	59·9
F.2	1	39·0	·70	do.	0·3	Three times through mill	61·3
F.3	1	39·0	·70	Gum Tragacanth 0·3	0·3	None	60·8
F.4	1	39·0	·70	do.	0·3	Three times through mill	62·2
F.5	1	39·0	·70	K-meel	0·3	None	57·4
F.6	1	39·0	·70	do.	0·3	Three times through mill	62·3

(*b*) *Concentration by Centrifugation.*—For the efficient production of 60% concentrate the latex separator installed at Dartonfield is recognised to be much inferior to certain other machines which are now available. Nevertheless by running the machine under various conditions of feed and adjustment, practical experience was gained which would be valuable to local producers who might contemplate the preparation of centrifuged latex for shipment.

An attempt was made to improve the performance of the separator by fitting specially made mid-plates with thinner abutments. This modification increased the D.R.C. of the cream for a given setting but it also reduced the capacity and efficiency of the machine. The same effect could be obtained equally well by using the normal mid-plates and limiting the rate of feed.

According to B.P. 490,781 the degree of separation in a latex centrifuge is much increased by adding soap to the latex together with a colloidal material. This claim was confirmed by repeated trials in which various gums, etc., were added to latex containing varying amounts of soap. Table II which gives the results of a typical series of trials shows that the suggested treatment does indeed cause a substantial reduction in the concentration of rubber in the skim and an increase in the efficiency of separation. Table III gives the results of another series in which varying amounts of soap were used in conjunction with sodium alginate.

TABLE II

Substances added to the Latex	Machine setting	D.R.C.		Efficiency
		Cream	*Skim*	
None	A	56·4	17·3	0·75
Soap 0·5%; Gum tragacanth 0·1% ...	A	52·1	10·0	0·89
Soap 0·5%; Sodium alginate 0·1% ...	A	52·0	3·0	0·98
None ...	B	59·6	16·2	0·77
Soap 0·5%; Gum tragacanth 0·1% ...	B	56·6	11·6	0·86
Soap 0·5%; Sodium alginate 0·1% ...	B	53·2	2·3	0·98

TABLE III

Sodium Alginate	Soap	D.R.C.		Efficiency
		Cream	*Skim*	
0·1%	None	53·7	6·4	0·92
0·1%	0·05%	52·6	5·1	0·94
0·1%	0·1%	53·0	4·2	0·95
0·1%	0·5%	53·1	2·9	0·97

It will be noted from these results, which are typical of many others, that the addition of gums, etc., results not only in a reduction in the skim rubber but also in the concentration of the cream. The latter can be increased by opening the skim screws, but this automatically allows more rubber to pass into the skim and tends to nullify the effect of the gum. Nevertheless with latex containing 0·1% of soap together with 0·1% of sodium alginate it was found that the machine could be adjusted to deliver 59/60% cream and 8/9% skim at a throughout rate of 30 gallons per hour and an efficiency of about 0·85. With ordinary latex without added gums, etc., the efficiency for this output of cream was never higher than 0·75 and the D.R.C. of the skim never lower than 15%, so that there appears to have been a definite improvement in performance as a result of the additions. The main objection to adopting the process is that it involves the addition of foreign materials to a grade of latex of which one of the chief advantages is that it is " purer " than other forms of concentrate.

Stability of Latex.—The stability of latex samples was formerly determined by stirring a mixture of latex and zinc oxide at a speed of 600 r.p.m. This test was in many ways unsatisfactory and has now been replaced by one in which the rate of stirring is 2,000 r.p.m. The latter test is referred to in what follows as the " high speed zinc oxide test " to distinguish it from the earlier low speed test. Parallel determinations designed to compare the results given by the two methods of testing did not reveal any close simple relationship and it was therefore not possible to connect the earlier results with those obtained by the new method. Periodical tests on Dartonfield latex using the high speed zinc oxide test have not yet been continued for a whole year, but up to the present there is no discernible relationship between stability variations and seasonal conditions.

The properties of latex from freshly opened tapping cuts are in some respects highly abnormal. To determine whether this abnormality extends to the property of stability, latex samples were taken at the first, second and tenth collections after the 1939 wintering period on the four divisions (A, B, C, and D) of Dartonfield. The samples were ammoniated, stored in glass bottles and tested at intervals by the high speed zinc oxide test (Table IV).

TABLE IV

Latex	Age when tested (days)	Stability (thous. revs.)			
		A	B	C	D
First collection after wintering	2	9·05	8·28	8·02	8·27
	14	17·61	17·28	20·24	19·79
	35	50·95	38·21	36·63	36·73
	90	—	60·27	60·94	—
Second collection after wintering	2	8·75	8·59	8·52	9·02
Do.	14	18·37	17·39	24·04	20·05
Do.	35	34·41	41·15	41·87	36·76
Do.	90	56·95	72·56	69·75	69·87
Tenth collection	2	8·33	10·43	9·43	10·50
Do.	14	21·21	28·32	22·59	20·97
Do.	35	36·63	42·82	33·64	33·09
Do.	90	67·22	50·58	60·17	61·81

The main conclusion to be drawn from these figures is that latex collected on the resumption of tapping after the resting period is not abnormally stable or unstable; such latex therefore is not shown by this test to be unsuitable for preservation and shipment. At the same time it cannot be concluded from the zinc oxide-stirring stability test alone that latex from freshly opened cuts would be satisfactory in every respect for preservation.

The value of the zinc oxide-stirring stability test lies in its ability to detect variations in quality which would not be so easily observed by other means. Low zinc oxide-stirring stability may or may not be associated with low stability under industrial conditions and the test provides no conclusive information about the suitability of a given sample for manufacturing purposes.

VARIABILITY OF RAW RUBBER

Special attention is now being given in Ceylon as in other rubber-growing countries to the problem of variability. Although the subject has for many years engaged the attention of research organisations, variability remains one of the foremost problems of the industry. The possibilities of improving the uniformity of plantation rubber have been recently reconsidered in the light of a set of tentative standards of uniformity upon which certain manufacturers have now agreed. The investigation has been taken up in Ceylon and Malaya and machinery has been set up to facilitate the co-ordination of views and effort between producers and manufacturers.

At the beginning of the year under review the work in progress in Ceylon was directed mainly towards the standardisation of testing methods. From parallel tests carried out by the Research Scheme and by the Rubber Research Institute of Malaya it has been shown that there exists a remarkably close agreement between the results obtained in the laboratories of the two Institutes. As slightly different testing methods were employed this agreement must be largely fortuitous; nevertheless the coincidence is useful because it facilitates the comparison of results obtained in the two countries.

Studies undertaken in 1939 were mainly exploratory and were designed to indicate which factors were chiefly responsible for the variability of plantation rubber and which were of relatively small importance. These studies will now be referred to under five headings :—

(*a*) **Variability in Dartonfield Estate Crepe.**—Monthly vulcanisation tests on smoked sheet and crepe from the four tapping divisions of Dartonfield were started towards the end of 1938. The purpose of these tests was to ascertain how much seasonal variation might be expected on an estate where well standardised methods of collection and preparation are employed.

Variation in vulcanising properties during the first year of the experiment was negligible. In particular it may be noted that the rubber obtained from the first collection of latex after wintering was not, as it is generally believed to be, markedly abnormal. The slight differences observed in the rubber-sulphur test (Table V) were in the direction of the rubber from newly opened cuts having a slower rate of cure. This was in conflict with the evidence of the test in the accelerated mixing and it is, therefore, proposed that further tests should be carried out after the 1940 wintering period.

TABLE V

Test Mixing	Time of vulcanisation Mins.	Rubber from first collection after resting one month ; average for all divisions of Dartonfield				Rubber collected during period 3 months before to 3 months after resting ; average for all divisions of Dartonfield			
		T_7'	T_8'	B'	L_B'	T_7'	T_7*	T_8'	B'	L_B'
*RS Mixing ...	120	0·27	0·45	1·08	10·63	0·30	0·30	0·50	1·17	10·61
*AM Mixing ...	60	0·36	0·66	1·42	10·48	0·32	0·32	0·57	1·26	10·49

*T_7 and T_8 = Load (kg. per sq. mm) at 700% and 800% elongation respectively ("modulus").
B = Tensile Strength (kg. per sq. mm).
L_B = Relative length at break.
RS Mixing = Standard Rubber—Sulphur test mixing.
AM Mixing = Standard Accelerated test mixing.

(*b*) **Variability in Ceylon Estate Rubber.**—A preliminary indication of the extent of variation in Ceylon estate rubber is afforded by the results of vulcanisation tests on thirty local estate samples. The small number of estates so far included in the investigation, coupled with the fact that those estates were not

selected at random (twenty were chosen because they produced abnormal rubber when samples were examined in 1931), makes it necessary to treat with reserve any conclusions which one might be tempted to draw from the results. A more extensive survey will be made in 1940. In Table VI the values obtained for the modulus of the thirty samples are tabulated in order of increasing modulus in the rubber-sulphur mixing.

TABLE VI

CREPE			SMOKED SHEET		
Estate No.	RS Mixing (T_8 for 120′/148° cure)	AM Mixing (T_7 for 60′/126° cure)	Estate No.	RS Mixing (T_8 for 120′/148° cure)	AM Mixing (T_7 for 60′/126° cure)
	Kg/sq. mm	Kg/sq. mm		Kg/sq. mm	Kg/sq. mm
10	48	36	22	45	35
15	48	36	24	52	43
17	48	35	23	62	50
6	49	35	30	65	57
1	50	32	25	71	47
7	51	29	27	72	52
12	51	37	28	89	63
4	52	35	29	90	76
19	54	41	26	91	56
9	55	41			
3	56	39			
13	56	44			
21	57	32			
18	61	40			
5	63	42			
20	64	46			
8	66	44			
16	66	46			
14	67	44			
11	71	58			
2	79	63			

It will be noted that there exists a definite though imperfect positive correlation between the modulus figures in the two mixings indicating that the information provided by the rubber-sulphur mixing is generally in agreement with that given by the accelerated mixing.

A report has recently been published of a similar examination of the properties of smoked sheet from 157 Malayan estates, and it is interesting to note that the distribution of modulus observed in the Malayan investigation is roughly equivalent to that found in Ceylon (Table VII).

TABLE VII

Modulus	Percentage of Total Number of Estates RS Mixing	
kg/sq. mm.	Ceylon	Malaya
<0·40	0	8
0·40—0·69	77	60
>0·69	23	32
	AM Mixing	
<0·40	37	13
0·40—0·59	53	60
>0·59	10	27

In comparing the results obtained in the two countries it must be remembered at the temperature of vulcanisation for the accelerated mixing in the Malayan tests (127 °C) differed from the temperature in the Ceylon tests (126 °C). Moreover, whereas the samples examined in Malaya were all smoked sheet, in Ceylon they were predominantly crepe. Hence although the parallelism observed in Table VII appears to indicate a similar distribution of properties in the estate produce of the two countries the evidence provided by the comparison is suggestive rather than conclusive.

(*c*) **Influence of Tapping Systems.**—The effect of different tapping systems on vulcanising properties was studied by examining rubber from the Dartonfield tapping experiment area. Considerable variations were observed but the figures were not readily interpretable. Further tests will be undertaken during 1940 at monthly intervals and discussion of the results will be deferred until further data are available.

(*d*) **Clonal Rubbers.**—Monoclonal rubbers from Nivitigalakele Experiment Station and from four other estates were submitted to vulcanisation tests in both the standard test mixings. Plasticity tests are also in progress but are not yet complete. The main point of interest that emerges from the vulcanisation tests is that nearly all the young buddings appear to yield high-modulus, fast-curing rubbers. Unfortunately all the areas of budded rubber in Ceylon are still very young and in only one case has it been possible to make a direct comparison between rubber from clonal blocks and rubber from seedlings of the same age. It is therefore not certain whether the observed abnormalities are characteristic of the clones in question or of young trees generally.

This investigation is handicapped at present by the relatively small number of areas of budded rubber of tappable age in Ceylon. From data so far collected no conclusions can be drawn about the existence of characteristic properties in clonal rubber.

PURIFIED RUBBER

(A) Small Scale Experiments

The production of rubber with a low water-absorptive capacity is of importance in connection with the insulation of cables and in the manufacture of all rubber goods which are normally used under conditions of high humidity. As the absorptive capacity of commercial rubber is due to the presence of non-rubber impurities (proteins, salts, etc.) the obvious way of attacking the problem is to investigate methods of purification.

The removal of nitrogenous and other substances from latex can be effected in a variety of ways but except in the case of the methods of multiple concentration there is little published information to show the relative effectiveness of various methods. A preliminary investigation was therefore started with the object of determining the degree of purification which could be achieved by (1) fractional coagulation, (2) the use of alternative coagulants, (3) treatment of latex with adsorptive materials, (4) digestion of latex with alkali, (5) extraction of coagulum with dilute saline solutions, (6) multiple concentration, (7) centrifugal treatment of fresh latex, (8) treatment of latex with fatty acids, etc.

In a series of 24 samples chosen at random from the products of early trials a high level of correlation ($r = 0.88$) was found to exist between nitrogen content (Kjeldahl) and water-absorptive capacity (suspension for 8 days in an atmosphere of 84% humidity). In the preliminary experiments promising products were therefore selected on the basis of their nitrogen contents and the direct determination of water-absorptive capacity was introduced only in the later stages of the investigation.

(1) **Fractional Coagulation.**—Samples of first and second fraction rubber made from the same bulk of latex were obtained from two neighbouring estates and compared with regard to their nitrogen content.

		Percentage of total weight of rubber	Nitrogen %
Estate A	1st Fraction	8	0·47
	2nd Fraction	92	0·28
Estate B	1st Fraction	15	0·48
	2nd Fraction	85	0·28

Although there is a preferential association of nitrogenous material with the first fraction, the latter represents such a small proportion of the whole that the extent of the purification accomplished is almost negligible.

(2) **Alternative Coagulants.**—In the course of some coagulation trials with centrifuge skim latex considerable variations in nitrogen content were observed with different coagulants. It was though possible that the nature of the coagulant might also influence the nitrogen content of rubber prepared from fresh latex and trials were accordingly made to test this possibility. The coagulants tried were acetic, formic and sulphuric acids, magnesium sulphate, sodium silicofluoride and mixtures of sodium silicofluoride with other coagulants. In no case was the coagulant observed to affect the nitrogen content of the rubber.

(3) **Adsorption.**—It is claimed (B.P. 455,674) that the treatment of preserved latex with adsorptive materials such as activated charcoal and silica gel results in the removal of nitrogenous material from the latex and a consequent reduction in the water-absorptive capacity of the dry rubber. Up to the present the results obtained in trials on these lines have been disappointing. Four types of activated carbon, three of kieselguhr, silica gel and "Hyflo-Supercel" have been used with fresh latex, with slightly ammoniated latex and, in the case of kieselguhr, with latex pre-treated with alkali at 80°. In only one or two cases, as the following table will show, was there a partial removal of nitrogenous material.

TABLE VIII

Number	Adsorbent	Nitrogen % In treated rubber	Nitrogen % In Control
PR 13	Activated Carbon No. 1	·27	·30
PR 3	Activated Carbon No. 2	·33	·33
PR 7	do.	·30	·28
PR 8	do.	·29	·28
PR 14	Activated Carbon No. 3	·27	·30
PR 1	do.	·16	·51
PR 4	Activated Carbon C/U	Latex coagulated	
	Silica gel	do.	
PR 9	Kieselguhr B/T	·16	·28
PR 15	do.	·25	·30
PR 20	do.	·30	·38
PR 23	do.	·10*	·11*
PR 27	Kieselguhr No. 1	·49	·52
PR 28	Kieselguhr No. 2	·51	·52
PR 16	"Hyflo-Supercel"	·29	·30

*Latex pre-treated with sodium hydroxide at 80°.

The positive result in PR 1 was obtained by using a very high concentration of adsorbent and a long contact period. The most promising trials from the point of view of the possible commercial application of the adsorption principle are considered to be those (PR 9, 15 and 20) in which kieselguhr was stirred with field latex and subsequently removed by settling or by centrifuging.

Purification by means of kieselguhr was then tried on a larger scale. Lightly ammoniated fresh latex was stirred mechanically with 25% (based on the rubber content) of kieselguhr and the latter was removed first by settling and finally by centrifuging in the Watson Laidlaw separator used as a clarifier (i.e. without mid-plates and with the skim channels blocked). The clarified latex after dilution to a D.R.C. of 10% was coagulated with acetic acid. As will be seen from Table IX there was a slight improvement in resistance to water absorption but scarcely any removal of nitrogenous constituents. The improvement was considered to be too slight to be of practical interest and no attempt was made to devise means of recovering the adsorbent after use.

TABLE IX

No.	Adsorbent	Nitrogen %	Water-absorption (Immersion): mgm/sq. in.
PR 86	Kieselguhr B/T	0·27	10·6
Control	None	0·28	15·4
PR 91	Kieselguhr H	0·25	11·0
Control	None	0·27	17·0

(4) **Digestion with Alkali.**—A substantial degree of purification is achieved by the hydrolysis of latex with alkali (B.P. 484,659) prior to coagulation. Field latex with 1% of sodium hydroxide was heated at 80° for 20 hours, diluted and coagulated with acetic acid.

TABLE X

Number	Nitrogen %	
	Alkali treated rubber	Control
PR 6	0·08	0·30
PR 22	0·11	0·38

Despite the low figures obtained for nitrogen content (Table X) the moisture-absorptive capacity of the samples was comparatively high. This may have been due to the presence of a residual proportion of the hydrolysis products but it seems more probable that the fixed alkali itself or the product of some secondary reaction was responsible for the high water-absorptive capacity.

Information on this point was sought by varying the conditions of the alkali treatment. Latex was treated at 65 ° for a short period (1 hour) with a stronger reagent (3% sodium hydroxide). Table XI shows that the absorptive capacities of the products were still very high.

TABLE XI

No.	Treatment	Nitrogen %	Water-absorption (Vapour) %
PR 55	3% NaOH, 1 hr. at 65°	·08	2·01
PR 55A	Ditto—coagulum washed by 37 passages through grooved mill	·05	1·60
Control	Crepe from untreated latex ...	·25	0·48

In the course of many trials sufficient evidence was obtained to show that the alkali treatment resulted in low water-absorption properties only when the latex was subsequently purified, for example by centrifuging or creaming, and it was concluded that alkali hydrolysis is useless as a means of reducing water-absorption unless the reagent and hydrolysis products are effectively removed from the latex before coagulation (Table XII).

TABLE XII

No.	Alkali treatment	Subsequent treatment	Nitrogen %	Water-absorption (Vapour) %
PR 50	½% NaOH, 20 hrs. at 65° ...	Once centrifuged	·09	0·25
PR 52	Do.	Twice centrifuged	·06	0·20
PR 56	5% NaOH, 20 hrs. at 65° ...	Three times creamed	·02	0·18

(5) **Extraction of Coagulum.**—It is well-known that the vegetable proteins of the class known as globulins are soluble in dilute salt solutions. To test the possibility of removing nitrogenous substances in this way some samples of freshly milled wet lace crepe were extracted for 40 hours at 26° with the solutions shown in the following table. After evaporating to dryness, the nitrogen contents of the extracts were determined :—

Solution	% Nitrogen extracted, calculated on dry rubber
Water	·007
Sodium chloride ... 0·5%	·003
Sodium chloride ... 1%	·005
Sodium chloride 3%	·007
Sodium sulphate ... 1%	·003
Sodium hydroxide ... 1%	·031
Sodium carbonate ... 0·4%	·018

In a second series of trials the extractions were done at 28° for 16 hours followed by 24 hours at 80°.

Solution		% Nitrogen extracted, calculated on dry rubber
Water		·007
Sodium hydroxide ...	1%	·034
Sodium carbonate ...	0·4%	·028
Hydrochloric acid ...	1%	·009

The results indicate that no extraction was brought about by neutral saline solutions but that alkalis caused a slight removal of nitrogen, presumably by hydrolysis.

(6) **Multiple Concentration.**—Removal of serum constituents by successively concentrating and diluting preserved latex forms the basis of a process by which low water-absorption rubber is already produced commercially. Trials in Ceylon only confirmed what is already well-known about this method of treatment. Multiple concentration is an effective and practical means of reducing the protein content and the water-absorptive capacity of the rubber. Centrifugal concentration is slightly more efficient than creaming. The limit beyond which the latex cannot be further purified by multiple concentration is reached when the nitrogen content is reduced to about 0.10%. Rubber prepared from alkaline latex in this way is characterised by rather poor ageing properties.

(7) **Centrifugal Treatment of Fresh Latex.**—It has been proposed in connection with the removal of foreign matter from latex that fresh field latex should be centrifuged before coagulation. The possibility of using the same means to effect a partial separation of the normal non-rubber constituents at once suggests itself and it is believed that the following results may be of some interest.

In each trial fresh field latex at a D. R. C. of about 20% was centrifuged in the Watson Laidlaw latex separator. In most cases the latex was first mixed with a temporary preservative to prevent premature clotting. The " creams " and "skims" were separately manufactured and then tested for nitrogen content, water-absorptive capacity, and vulcanising properties. As space does not permit the inclusion of the results of all these trials they must be summarised. The " skim " fractions, containing an accumulation of non-rubber substances possessed high water-absorptive capacities, high modulus in the vulcanisation test and a marked tendency to discolour. This was in accordance with expectations. The " cream " rubbers showed in most cases a substantial improvement in water-absorption properties.

In view of these promising results larger quantities of fresh latex were centrifuged and the separate fractions were coagulated with acetic acid. The results are shown in Table XIII. A point of interest is that this improvement was more marked than one would have expected from the concomitant small reduction in nitrogen content. The fact that the products were relatively water-resistant without having lost a large proportion of their nitrogenous non-rubber constituents leads to speculation on the possibility of producing by this method water-resistant rubber with relatively unimpaired ageing qualities. At the time of writing ageing trials were still in progress.

(8) **Treatment with Fatty Acids, etc.**—Experiments carried out by the aff of the London Advisory Committee have shown that protein is displaced om the caoutchouc-serum interface by certain fatty acids and soaps. As this ould appear to present a means of completely deproteinising latex without ie use of hydrolysis agents, one or two trials on the same lines were started in eylon with fresh latex. From these trials alone it seemed doubtful whether ny displacement of protein did occur. However, in view of the positive results the London experiments and the limitations of those hitherto carried out in eylon further comment must be deferred until there is an opportunity of studying ie question more systematically.

(B) Semi-Commercial Scale Production

In Ceylon the only effective method of purification that could be adopted short notice and small capital cost would be the method of multiple creaming. hile this method may not be ideal it is capable of yielding a product with reason-ly good water-absorption properties at a cost of production not greatly in excess that of normal estate crepe. For this reason it has been thought desirable to ive consideration to the commercial production of purified rubber by

TABLE XIII

Sample No.	Proportions by Weight	Anti-Coagulant %	Nitrogen %	Water-Absorption		Modulus	
				Vapour Method	Immersion Method	RS Mixing	AM Mixing
				%	mgm/sq. in.	kg/sq.mm	kg./sq.mm
R 82 Cream ...	86	Formalin ·05	0·19	0·18	7·5	0·32	0·17
R 82 Skim ...	14	do.	0·97	0·97	21·1	—	—
R 84 Cream ...	85	Ammonia ·08	0·16	0·22	8·7	0·33	0·27
R 84 Skim ...	15	do.	0·95	1·29	27·6	—	—
verage Dar-tonfield crepe	—	—	0·28	0·65	18·1	0·50	0·32

ouble creaming and to study the influence of simple modifications of this basic rocess.

1. **Basic Process.**—Ammoniated Dartonfield latex was creamed, diluted o a D.R.C. of 35% and re-creamed. The secondary cream diluted to a ow concentration was coagulated by slow addition of formic acid and creped ith a copious flow of water on the mill. Drying took 7 days compared with $\frac{1}{2}$ to 3 days for normal estate crepe. The properties of the product (PR 95) re shown in Table XIV.

TABLE XIV

Description	Nitrogen %	Water-Absorption		Modulus	
		Vapour %	Immersion mgm/sq. in.	RS Mixing kg/sq. mm.	AM Mixing kg/sq. mm.
PR 95 from twice creamed latex...	0·15	0·18	6·5	0·36	0·35
Average Darton-field crepe ...	0·28	0·65	18·1	0·50	0·32

Three chests of PR 95 were forwarded to London for manufacturers' report.

2. **After Treatment of Coagulum.**—It has been shown by Boggs & Blake (J.I.E.C. 1936, 28. 1198) that the prolonged washing of rubber is almost ineffective as a means of purification. But what is true of dry commercial rubber might not be equally true of freshly made coagulum, and it was thought desirable to determine what degree of purification might be obtained during preparation by mechanical means.

Freshly milled crepe made by coagulating once creamed latex was divided into four parts and submitted to the following different treatments :—

PR 99 Dried in warm air room without further treatment.
PR 100 Soaked for 3 days in water with 6 changes.
PR 102 Soaked for 3 hours in water at about 80 °C. Re-creped.
PR 103 Steamed for 3 hours in autoclave at 110 °. Re-creped.

From Table XV it will be observed that while soaking and autoclaving treatments did not result in any further removal of nitrogenous substances the rubber which had been soaked for 3 hours in hot water (PR 102) showed a tendency towards greater absorption resistance. The improvement was slight, however, and may not have been significant. Vulcanisation properties were not affected by the soaking treatment, but slightly lower modulus figures were obtained in the case of the autoclaved rubber.

TABLE XV

No.	Drying time—days	Nitrogen %	Water-Absorption		Modulus	
			Vapour	Immersion	RS Mixing	AM Mixing
			%	mgm/sq. in.	kg/sq. mm.	kg/sq. mm.
PR 99 ...	5	0·19	0·30	9·5	0·61	0·55
100 ...	6	0·20	0·36	11·4	0·58	0·58
102 ...	4	0·19	0·28	8·4	0·63	0·49
103 ...	4	0·18	0·31	8·6	0·51	0·46

3. **Addition of Antioxidants.**—In view of the relatively poor ageing properties that purified rubber, particularly rubber from alkaline latex, is known to possess, some preliminary attempts were made to devise a suitable method of incorporating age-resisting substances into the latex prior to coagulation. Promising results were obtained by dissolving the age-resisting substance in a minimum quantity of benzene and using an aqueous emulsion of the solution so obtained.

4. **Creaming Fresh Latex.**—In order to cream latex to a D.R.C. sufficiently high to conform to the market standard for concentrated latex (60%) it is generally necessary to allow the latex to mature for a period before creaming. At Dartonfield it is usual to allow four days to elapse between collection of the latex and addition of the creaming agent. In the concentration of latex for purification, however, it should not be necessary to cream to so high a concentration and it might therefore be possible in practice to economise latex storage space by creaming fresh latex. Table XVI records the results of two trials which were made to compare the efficiency of various creaming agents when used with fresh (i.e. less than 24 hours old) Dartonfield latex. It will be observed that Tragon A under these conditions was considerably more efficient than the other creaming agents.

TABLE XVI

Creaming Agent % on liquid phase	Soap % on liquid phase	Concentration and proportion of cream after 24 hours creaming			
		Original D.R.C. 33·6% Original NH_3 0·25%		Original D.R.C. 32·67% Original NH_3 0·25%	
		D.R.C. of cream %	Proportion of cream %	D.R.C. of cream %	Proportion of cream %
Tragon A, 0·3 ...	0·3	55·7	55·6	55·5	53·8
Do. ...	None	51·1	55·0	49·2	58·0
Sodium Alginate (low viscosity) 0·3	0·3	48·0	64·2	46·5	58·5
Do. ...	None	39·8	74·6	35·0	81·2
Gum Tragacanth 0·3	0·3	51·5	61·4	50·0	62·0
Do. ...	None	38·6	81·8	42·3	59·2
K-meel 0·3	0·3	52·3	58·7	50·7	59·5
Do.	None	40·2	79·2	38·2	71·6

(5) **Secondary Creaming.**—Creaming agents were also compared in the secondary creaming process. Primary cream was diluted to 35% and re-creamed with creaming agents shown in Table XVII. Only the qualitative character of the separation after 24 hours is recorded but it will be observed that in this series both Tragon A (0.3%) and Sodium alginate (high viscosity) (0.15%) were effective.

TABLE XVII

Creaming Agent, % on liquid phase	Soap % on liquid phase	Separation after 24 hours
Tragon A, 0·3	0·3	Clear underlayer
Do.	None	do.
Tragon A, 0·2	0·3	Milky underlayer
Do.	None	do.
Sod. Alginate (low viscosity), 0·1%	0·3	No sign of creaming
Do. do.	None	do.
Sod. Alginate (low viscosity), 0·15%	0·3	Very milky underlayer
Do. do.	None	No sign of creaming
Sod. Alginate (high viscosity), 0·1%	0·3	Very milky underlayer
Do. do.	None	do.
Sod. Alginate (high viscosity), 0·15%	0·3	Very clear underlayer
Do. do.	None	Fairly clear underlayer

MISCELLANEOUS

Rubber Coagulants.—Of late years imports of rubber coagulants into Ceylon have been largely derived from Germany and the sudden stoppage of supplies at the outbreak of war caused much anxiety among those producers whose stocks were inadequate to carry them over the period of disorganisation of shipping. Numerous appeals for advice were addressed to the Research Scheme by producers of all classes and a considerable amount of time had to be devoted to the examination of substitute coagulants of various kinds.

Reports from local importers regarding the prospects of an early resumption of normal supplies have from the first been reassuring. It is stated that formic and acetic acids are procurable in Britain, Holland, Canada, France and Australia, and the general opinion is that by February, 1940, adequate supplies will be coming forward from these alternative sources. The Research Scheme suggested to the Department of Industries that the risk of a temporary shortage of coagulants should be met by importing from India one or two months supply of sulphuric acid. Towards the end of the year there had arisen an acute shortage which caused considerable hardship to many producers, particularly smallholders, and which was favourable to the development of schemes and suggestions for the production and sale of acetic and formic acid "substitutes."

The views of the Research Scheme on the use of alternative coagulants were expressed in a planting memorandum; in an article published in an issue of the Quarterly Circular dated December, 1939; and in a communication to the daily press. It was conceded that in an emergency it might be necessary to use almost any substitute but it was urged that preference should be given to those

terials such as sulphuric acid whose influence on the technical properties of ber was well-known. Sulphuric acid was not free from objections as a agulant but if used with care it was capable of producing first grade rubber d it was, moreover, the only alternative coagulant likely to be available in equate quantities at short notice. Rubber producers were warned to be spicious of proprietary substitutes of undeclared composition and were advised resume their normal procedure at the earliest possible opportunity in order to intain the Island's reputation for producing good quality rubber. Information s given nevertheless on the use of such coagulants as pyroligneous acid, negar, fermented coconut water, lime juice, goraka extract, etc., and on the use sugar to induce spontaneous coagulation.

On the experimental side attention was given to the possibilities of coagulating ex with various materials and products of local origin.

Sugar.—Although the idea of using cane sugar to stimulate spontaneous gulation is not new, and there is already a fair amount of information available the properties of rubber prepared in this way, all the published conclusions he past have been based on vulcanisation tests made in pure rubber-sulphur ings. It was therefore though desirable that some samples of sugar-coagulated bber should be made and judged by more modern standards.

Dartonfield latex was mixed with sugar in the proportion of 1 part of sugar 100 parts of rubber. Coagulation occurred overnight and the coagulum was verted into crepe in the usual way. The rubber was examined for water-orption and vulcanising properties in the accelerated test mixing. The sults are given in Table XVIII together with corresponding figures for Darton-d crepe coagulated in the normal way with formic acid. These results serve illustrate how a change from formic acid to sugar might result in an important nge in vulcanising and other properties which would be highly undesirable.

TABLE XVIII

Method of Coagulation	Nitrogen %	Water-Absorption		AM Mixing
		Vapour %	Immersion mgm/sq. in.	Modulus kg/sq. mm.
ith sugar	0·39	0·80	21·7	0·69
ith formic acid	0·28	0·65	18·1	0·32

The rubber was decidedly off colour and was assessed by Colombo brokers at 03 cents below the price of contract crepe.

Pyroligneous Acid.—The commercial practicability of collecting and ilising the volatile products which normally are lost during the manufacture coconut shell charcoal is being investigated by the Coconut Research Scheme

in conjunction with the Department of Industries. Two samples were prepar by the Director of the Coconut Research Scheme and forwarded by him f examination as latex coagulants. The samples were, (1) crude pyroligneo acid containing 10.8% of acetic acid and a considerable amount of dissolved ta and (2) redistilled pyroligneous acid containing 11.1% of acetic acid and relatively small amount of tar.

In sheet manufacture both samples of pyroligneous acid gave a coagulu which was discoloured and pasty. This effect was probably due to the activatio of the latex oxidase by phenolic substances present in the acid. The amount discolouration varied somewhat from day to day owing possibly to variations i the composition of the latex. In the preparation of crepe the discolouration wa prevented by the sodium bisulphite present in the latex. The addition of a little as 0.05% to 0.10% of bisulphite (based on the dry rubber) was sufficient t ensure satisfactory coagulation with pyroligneous acid.

Table XIX gives the results of vulcanisation tests and indicates that th rubber produced by pyroligneous acid coagulation is uniform in vulcanisatio properties with normally coagulated rubber. The results of the ageing tests i the accelerated (mercaptobenzothiozole) mixing (Table XX) are evidence of th good ageing properties of both crepe and smoked sheet coagulated wit pyroligneous acid. It is concluded from these trials that pyroligneous aci obtained from the distillation of coconut shells may be safely used as an emergenc coagulant provided it is produced under properly controlled conditions. Th qualification contained in the last sentence is necessary because reports have bee received of enterprising villagers who are making acid liquors for latex coagulatio by dry distilling coconut shells in stills fitted with brass condensers.

TABLE XIX

Coagulant	Form of Manufacture	Modulus	
		RS Mixing	AM Mixing
		kg/sq. mm.	kg/sq. mm.
Formic acid	Crepe	0·60	0·32
Acetic acid	do.	0·57	0·33
Pyroligneous acid, crude	do.	0·57	0·32
Pyroligneous acid, redist.	do.	0·53	0·33
Formic acid	Smoked sheet	0·43	0·37
Acetic acid	do.	0·45	0·41
Pyroligneous acid, crude	do.	0·44	0·43
Pyroligneous acid, redist.	do.	0·45	0·40

TABLE XX

Ageing of Accelerated Mixing (40′/127° cure)

Coagulant	Form of manufacture	Tensile strength after ageing (days) at 70°C. kg/sq. mm.				Modulus T_7 after ageing (days) at 70°C. kg/sq. mm.			
		0	6	12	24	0	6	12	24
rmic acid	Crepe	1·05	1·33	1·25	1·15	0·31	0·61	0·70	0·82
tic acid	do.	1·07	—	1·26	—	0·32	—	0·71	—
roligneous acid, crude ...	do.	1·15	—	1·22	—	0·31	—	0·66	
roligneous acid, redist. ...	do.	1·07	1·32	1·18	1·19	0·31	0·62	0·67	0·84
rmic acid	Smoked sheet	1·08	1·46	1·40	1·30	0·35	0·73	0·76	0·87
tic acid	do.	1·22	1·48	1·43	1·34	0·40	0·76	0·80	1·00
roligneous acid, crude ...	do.	1·15	1·45	1·38	1·38	0·38	0·75	0·87	1·13
roligneous acid, redist. . .	do.	1·20	1·44	1·37	1·28	0·37	0·71	0·82	1·06

Re-use of Serum.—The Director of the Rubber Research Institute of laya kindly forwarded a copy of a preliminary report on the re-use of serum as eans of reducing the quantity of acid required for coagulation. In these s it had been found at Sungei Buloh Experiment Station that the dose of d could be reduced to about half if a proportion of the serum from the previous 's coagulation was added to the latex. The method was later described in bber Research Institute of Malaya, Circular No. 8.

In trials of the method undertaken at Dartonfield coagulation was found to be y incomplete when latex (previously diluted to a dry rubber content of $2\frac{1}{4}$ lbs. gallon) was treated with half its bulk of serum followed by half the normal e of fresh acid. Moderately good coagulation was usually obtained when 2/3-4 the normal dose of acid was used but the completeness of coagulation varied m day to day, presumably owing to minor variations in the composition of the x. After re-using the serum for several successive days coagulation became atisfactory owing to the development of putrefaction. The appearance of et and crepe rubber prepared during the trials was quite satisfactory except a slight cloudiness and tendency to bubbles in the sheet samples. Vulcanion trials are in progress.

The difference in the results obtained at Sungei Buloh and Dartonfield ggests that the value of the method may vary according to the character of the ex on different estates. The method was recommended for trial on estates in publications already referred to.

Addition of Calcium Salts.—The addition to latex of soluble calcium salts gether with normal coagulants is also suggested as a possible means of reducing consumption of acetic and formic acids. For the coagulation of fresh latex 20 % D.R.C. the usual proportion (volume/weight) of formic acid to dry bber is between $2\frac{1}{2}$ and $3\frac{1}{2}$ parts per 1,000 parts of rubber. But in the presence

of calcium ions complete coagulation can be obtained with much smaller doses acid. A series of trial coagulations was made with varying proportions formic acid in conjunction with calcium acetate or lactate, and two or thr mixtures were selected for further trial. As calcium ions tend to promo enzymatic discolouration in latex which does not contain sodium bisulphite it w found to be advisable in sheet manufacture to add a small quantity (say 1:1,000) bisulphite to prevent undue surface discolouration.

TABLE XXI

Coagulant (per 1,000 parts of rubber)	Form of Manufacture	Modulus	
		RS Mixing T_8 for 120′ 148° cure	AM Mixin T_7 for 60′/ 127° cure
		Kg/sq. mm.	Kg/sq. mm
Formic acid 3	Crepe	0·60	0·32
Formic acid 0·6 Calcium acetate 5	do.	0·86	0·45
Formic acid 3	Smoked sheet	0·43	0·37
Formic acid 1 Calcium acetate 3 Sodium bisulphite 1	do.	0·51	0·41
Formic acid 0·6 Calcium acetate 5 Sodium bisulphite 1	do.	0·52	—

The vulcanisation tests (Table XXI) showed a tendency for the sample coagulated with reduced amounts of acid to possess a higher rate of cure. Thi might have been expected as a result of the higher rate of " maturation " in the les strongly acid coagula.

TABLE XXII

Ageing of Accelerated Mixing (40′/127° cure).

Coagulant (per 1,000 parts rubber)	Form of manufacture	Tensile strength after ageing (days) at 70°C Kg/sq. mm.				Modulus T_7 after ageing (days) at 70°C Kg/sq. mm.			
		0	6	12	24	0	6	12	24
Formic acid 3	Crepe	1·05	1·33	1·25	1·15	0·31	0·61	0·70	0·8
Formic acid, 0·6 Calcium acetate 5	do.	1·18	1·31	1·32	1·28	0·42	0·74	0·87	1·0
Formic acid 3	Smoked sheet	1·08	1·46	1·40	1·30	0·35	0·73	0·76	0·8
Formic acid 1 Calcium acetate 3 Sod. bisulphite 1	do.	1·25	1·60	1·36	1·22	0·40	0·77	0·78	0·9
Formic acid 0·6 Calcium acetate 5 Sod. bisulphite 1	do.	1·05	1·38	1·39	1·22	0·28	0·61	0·67	0·7

Ageing tests in the accelerated mixing (Table XXII) showed that the experimentally coagulated samples possessed normal resistance to ageing. It is considered that in the event of a prolonged curtailment of supplies of normal coagulants this means of reducing consumption might be given further attention. The utility of the method depends, of course, on the availability of a suitable calcium salt, but the possibility of using salts of other metals (such as magnesium) may be borne in mind.

Estate Manufacture.—No important changes were made in the manufacture of the estate crop which was prepared, as in previous years, in the form of crepe, smoked sheet and preserved latex. The sheeting battery which was installed at the end of 1938 by the local agents for demonstration purposes was put through a number of trials and a full report on the working of the battery was prepared towards the end of the year.

Meteorological Observations.—The summary of weather records for 1939 is as follows :—

	1939	1938
Rainfall (ins.)	175·21	151·85
Highest monthly rainfall (ins.) ...	27·89 (August)	25·52 (April)
Highest daily rainfall (ins.)	21·03 (Aug. 9th)	4·61 (April 6th)
Highest shade temperature (day) ...	94·7° (March 1st)	92·2° (Feb. 24th and March 30th)
Lowest temperature (night)	60·4° (Dec. 7th)	65·8° (Jan. 8th)
Number of rainy days	226	249

Enquiries and Correspondence.—Enquiries were dealt with on the following chemical subjects :—

Latex	10
Preserved Latex	11
Factory Procedure and Equipment	37
Drying House Design...	19
Defects in Raw Rubber...	3
Alternative Forms of Raw Rubber	13
Vulcanised Products	22
Latex Coagulants...	37
Miscellaneous	23
Total ...	175

Publications.—The following articles was published in the Combined Third and Fourth Quarterly Circular for 1939 :—

" Latex Shipment."

(Sgd.) M. W. PHILPOTT,
Chemist.

Research Laboratories,
Dartonfield,
Agalawatta.

REPORT OF THE BOTANIST AND MYCOLOGIST FOR 1939

STAFF

The staff of the Botanical Division and the allocation of duties were as follows :—

(1) R. K. S. Murray, Botanist and Mycologist. All pathological work, advisory work on botanical and general agricultural problems, tapping investigations, study of clones, etc.

(2) C. A. de Silva, Assistant Botanist. Supervision of all field experiments at Dartonfield for both Botanical and Soils Divisions and statistical analysis of results. Study of natural covers, miscellaneous botanical investigations.

(3) C. E. Ford, Geneticist. Selection and breeding, study of clones, cytogenetics, bark anatomy.

The staff was at full strength during the greater part of the year. Mr. Murray was absent on sick leave from 6th July-9th October, and Mr. de Silva was in temporary charge of the Smallholdings Department in addition to his other duties from the 10th June-18th September. Dr. Ford was also absent on military duty during September so the Division was severely depleted during the third quarter. During Mr. Murray's absence disease specimens and pathological enquiries which could not readily be dealt with at Dartonfield were referred to the Plant Pathologist, Department of Agriculture, whose assistance is gratefully acknowledged.

PATHOLOGICAL WORK

Oidium Leaf Disease

General.—The refoliation season of 1939 was an exceptionally interesting one for the study of Oidium as it revealed new aspects of the relationship between the incidence of the disease and climatic factors. Hitherto severe attacks in the low-country had been associated with dull, wet weather which is not normal during the period of refoliation. The unusual intensity in 1938, for example, was rightly attributed to this circumstance. The early months of 1939, on the other hand, were characterised by exceedingly dry weather, yet on some low-country estates, or portions thereof, the disease caused greater defoliation than ever before. The explanation would seem to lie in the exceptionally low range of minimum temperatures experienced in January and February, meteorological conditions being thus akin to those at mid-country elevations.

A full report on the subject was published in the Second Quarterly Circular of which the summary is quoted below :—

" 1. Severe attacks of Oidium in the low-country have hitherto been associated with unusually wet weather at the time of refoliation. In 1939 the disease caused considerable damage in certain localities despite very dry weather.

2. A study of meteorological records at Dartonfield suggests that very ow minimum temperatures during January and February were responsible for he severity of the disease, the fungus being known to be favoured by low tem- eratures.

3. The low minimum temperatures were not offset by particularly high aximum temperatures, which might have checked the activities of the fungus.

4. Despite the dry weather the atmosphere was unusually humid in the arly mornings, and this, again, favoured Oidium.

5. In the Matale district the exceedingly dry weather was ideal for sulphur usting operations and, except at the highest elevations where no treatment as undertaken, the foliage is healthy and often very heavy.

6. Since the cold spells in January and February are unusual there is no eed to modify in any important respect the present recommendations for sulphur usting on low-country estates. Such spells should be recognized as a warning hat a severe outbreak of Oidium may follow, and the first application of sulphur ade at a higher rate than usual.

7. Attention is again directed to the importance of starting the dusting ogramme before any appreciable fall of young leaf has occurred, and to the ecessity of maintaining an elastic rather than a hard and fast programme."

Sulphur dusting was, in general, extremely successful in the Matale district judged by the contrast between the heavy foliage on estates in which the treat- ent was undertaken and neighbouring areas which were left undusted. The sults on some low-country estates, on the other hand, were disappointing. In ertain instances the failure could be ascribed to such factors as poor quality ulphur, insufficient rate of application, too late a start or inadequate supervision, ut in others it is difficult to provide an explanation. The results on Dartonfield, or example, were patchy, and a report was received from one Superintendent ho had the paradoxical experience of achieving almost complete control at an levation of up to 2,300 feet, but had disappointing results lower down on the me hillside. It is possible that a study of localised differences in meteorological onditions, particularly humidity, might shed interesting light on this problem.

Experimental.—

Field Trials of Dusting Sulphurs.—A trial was carried out on two mid-country tates with the object of comparing the efficacy of four brands of dusting sulphur. he size of each plot was approximately 20 acres and the experiment was replicated our-fold, two blocks on each estate. The treatment was carried out by the states on ordinary commercial lines, the only special feature being the use of he several brands. The total rate of application was 42 lb. per acre in three f the blocks, while the fourth, being at a lower elevation, received only 24 lb. esults were judged by general observation and also by the examination of he foliage of each individual tree in four sub-plots of 10 trees each which were narked in each plot at the commencement of operations.

Two of the brands used were standard products with 90-95% sulphur ontent, and these gave the best control. Of the other two, one gave very

poor results and can be written off as of little value. The other is a relatively inexpensive product and was found to have excellent physical and cloud-forming properties largely on account of the high proportion of inert bituminous matter. This inert matter might be of value in enhancing the adhesive properties, and an admixture of this substance with a purer sulphur would be worth a trial.

The relative merits of various brands of dusting sulphur are, however, of mainly academic interest during the war as the sources from which sulphur is available are limited.

Development of Resistant Clones by Selection and/or Breeding.—As a basis for selection or breeding work it is necessary to find trees which display a useful degree of resistance to Oidium infection. Preliminary observations made in 1929 gave entirely negative results, but the co-operation of 34 estates in the Matale district has now been obtained in the search for such trees. 1,107 trees which had conspicuously healthy foliage in 1939 were marked on two estates for further observation, and the other estates have undertaken to co-operate in 1940.

As a further means of investigating this problem, negotiations are in progress for the lease of a block of land on a mid-country estate with the idea of planting a " museum " collection of high-yielding and promising clones in the hope that some may be found to be resistant to Oidium.

Root Disease

Numerous specimens of plants killed by root disease in replanted clearings continue to be received, the most important fungi being *Fomes lignosus* and, to a lesser extent, *Poria hypobrunnea*. The maximum loss occurs in the second or third year from planting, the trouble being much reduced thereafter. This is doubtless largely due to the eradication of sources of infection consequent on the control measures, but there is evidence that the fungi tend to relapse into quiescence even where infected old roots are left in the ground. This may be due to their invasion by saprophytic organisms which compete strongly with the disease fungi, or to greater resistance of the Rubber plants with increasing age.

Several estates with a high incidence of *Fomes lignosus* in young replantings were advised to undertake the treatment developed by the R.R.I. of Malaya, which consists of the systematic examination of the root system of every individual plant at periodic intervals. Reports received from those estates show that the treatment is quite feasible under Ceylon conditions, the costs varying from Rs. 1.25 to Rs. 4 per acre per round according to the extent of the exposure. Plants which are found to have an external growth of the fungus but no penetration of the tissues are treated by rubbing off the mycelium with a solution of copper sulphate, and these have usually been found to be quite healthy on the next examination 4-9 months later. The source of infection, of course, is traced and removed.

As mentioned in the Report for 1938, an experiment was laid down on one estate to determine the value of this form of treatment, four plots being subjected to individual tree examination and four left as controls. Up to the

d of 1939 there is no indication that the early disclosure of sources of infection nsequent on this measure has been of any value in reducing either the number size of patches which have to be treated, though a number of plants have en saved which would probably otherwise have died. In the early stages the treatment, of course, the number of Fomes patches is apparently increased d it remains to be seen whether this will be offset by fewer losses in later years.

Die-Back of Pueraria

Much concern has justifiably been occasioned during the year by the deteriora-on or death of covers of *Pueraria phaseoloides* over extensive areas under mature ubber. Records of such damage have been received from 20 estates in the elani Valley and two in the Kalutara district, no other species of cover crop aving apparently been affected.

The main features, as evidenced by reports from Superintendents and visits aid to estates, are as follows :—

(1) With one exception, the damage has only been observed under mature ubber. On one estate, however, the die-back had "spread" from a 1932 ring, where the foliage was dense, to a contiguous area replanted with Rubber 1936. In the latter area, however, the cover had been growing for some ars prior to 1936.

(2) In every instance so far recorded the cover had been growing for at ast four years, and usually longer. Younger covers have remained quite ealthy even in adjoining fields.

(3) The cover disappears completely in a few weeks in patches of varying ze, viz., from a few square yards to several acres. The leaves first turn yellow, n brown, and the process is more like the death of an annual plant than degenera-on due to an actual pathological condition. A few plants may survive and ese, after looking rather yellow for a period, usually start to put out healthy ew growth. This is usually the state of affairs on the occasion of the writer's isit of inspection. These surviving plants show normal root nodulation, ut the nodules on plants which are actually dying are dry and empty.

(4) The only pathological organism found is the root nematode (eelworm), *eterodera marioni*. This is almost universally present, but in most cases investi-ated the degree of infestation has not been sufficiently severe to suggest that elworm is the primary cause. Moreover, it has usually been possible to find e typical galls in neighbouring healthy covers.

(5) In some instances drought appears to have been a contributory factor the cover died back during or shortly after one of the two marked dry periods perienced in 1939, viz., January/February and August/September, and recovered n the advent of rains.

(6) In general the trouble has occurred on poor soils (often old, eroded a land) which have not received any phosphatic manure in recent years. There e exceptions, however, to this general observation. Neither applications of trogen nor cultivation by forking appear to assist in the maintenance of the over.

The matter is receiving further investigation, but at present it would appea that the damage is due to the phenomenon known as " soil sickness." Th farmer in temperate countries knows that it is unsatisfactory to grow a legum inous crop continuously in the same soil and he therefore adopts the expedien of crop rotation. The same phenomenon has been reported in connectio with leguminous cover crops in Java, and was probably also responsible fo the death of Vigna on Rubber estates in Ceylon about 10 years ago. The exac nature of " legume sickness " is somewhat obscure, but it may be the con sequence of the lysis of the nodule bacteria by a bacteriophage (akin to virus)

The length of time which will elapse between the establishment of the cove and the symptoms of " sickness " may be expected to vary according to th nature and treatment of the soil. Thus, where conditions are in every respec favourable for the cover, as in an open clearing well supplied with phosphate the plants may retain their vigour for many years, whereas on poor soil unde the shade of mature trees the somewhat precarious balance of existence is easil upset. (It is also possible that the nitrogen economy of plants with root nodule differs according to the amount of direct sunlight received). Similarly a mil infestation by eelworms, which could be tolerated by a cover growing unde favourable conditions, might in certain circumstances be " the last straw whic breaks the camel's back."

The ideal remedy for such a condition lies in a regular rotation of covers and estates have been advised :

(1) To endeavour to establish other legumes such as *Desmodium ovalifolium Centrosema pubescens*, *Dolichos Hosei* (Vigna) and *Tephrosia candida* (Boga).

(2) To encourage non-leguminous weeds of a desirable type, grasses an certain ferns being rigidly excluded.

(3) To apply fertiliser mixtures containing phosphate to healthy covers wit the object of preventing or at least arresting deterioration.

As mentioned above there is evidence of recovery in some of the affecte areas, and it is possible that Pueraria may grow again satisfactorily after the soi has been " rested " for some months. Some Superintendents are endeavourin to re-establish Pueraria with the assistance of manure, and the results of all thes trials will be carefully watched.

Bird's-Eye Spot (*Helminthosporium Heveae*)

Observations made in a stock nursery of 1938 seedlings at Nivitigalakel indicate that a light overhead shade gives a substantial degree of control o " bird's-eye spot " disease. A number of beds selected at random were shade with cadjans at a height of about 7 ft. from the ground, the age of the plant being about 5 months at the commencement of the trial and infection uniforml heavy. There could be no doubt that the young shoots and leaves produce under the shade were much healthier than those in adjacent unprotected bed though whether this is mainly due to the effect of the modified conditions on th fungus or on the host is not known. The result suggests that it would b

useful to establish high shade trees such as Albizzia in areas which are to be used as nurseries for several years.

Satisfactory control of the disease was also obtained in the same nursery by spraying with Perenox, a new copper fungicide. This is particularly interesting in view of the disappointing results previously obtained with other spray fluids.

BOTANICAL WORK

The Improvement of Planting Material

A. Budgrafting.

1. Selection of Mother Trees

As mentioned in the Report for 1938, the yield records and other characteristics of several hundred trees derived from seed from the Tjikadoe Seed Garden in Java were studied and a final selection of 29 mother trees was made early in 1939. A clone consisting of 20 buddings was established from each of these trees and planted in the 1939 clone trial area at Nivitigalakele. New clones were also established from 3 marcots at Nivitigalakele and one high yielding estate mother tree.

A census of the yield of every individual tree on Dartonfield was started during the year and more than half the area has been completed. A second round will be carried out as soon as the first has been finished, and thereafter any tree which gave a yield of 300 ccs. of latex for each tapping (double-four system) will be marked for accurate yield recording.

2. Budding, Planting and Attention

No experimental work has been done on the technique of the budding operation.

An experiment was commenced at the end of 1938 to compare various forms of treatment in connection with the transplanting of budded stumps. The treatments were :

A. Planting stumps with all lateral roots pruned to the tap root.

B. Planting stumps with all lateral roots left as intact as possible, only damaged roots being pruned.

C. As B, but ring-barking the stocks in the nursery 10 days prior to transplanting.

D. Planting stumps after cutting through lateral roots with a spade in the nursery 1 ft. away from the stump 14 days prior to transplanting.

E. As A, but syringing the soil around the stump with $\frac{1}{2}$ pint Hortomone A* solution 1 in 320 immediately after planting.

F. As E, but lateral roots left intact as in B and C.

The experiment was laid out in 10 randomised blocks, 4 stumps of each treatment comprising a plot. A different local clone was used in each block. In addition the stumps were divided into two categories by size :

*A patent "growth promoting substance."

X. Large stumps, average girth 4.4 in.

Y. Small stumps, average girth 3.6 in.

Periodic observations were made on rate of sprouting, number of casualties and height of shoot and the results are summarised in Table 1.

TABLE I

Budded Stump Planting Experiment

Treatment	Mean No. of days to sprout	Percent. deaths	Mean height of shoot in inches 12 months after planting
A	46	2·5	56·5
B	41·5	0	66·8
C	37	0	68·2
D	41	0	73·4
E	44	5·0	54·4
F	38	0	68·8
Mean	41·25	1·25	64·7
Standard Error	2·0	—	3·6
Sig. Diff. (P. =·05)	5·5	—	10·2
X	41·5	1·7	68·7
Y	41	0·8	60·8
Mean	41·25	1·25	64·7
Standard Error	—	—	1·7
Sig. Diff. (P. =0·5)	—	—	5·4

The conclusions formed are as follows :—

(1) *Rate of sprouting.*—The preliminary ring-barking advanced the average date of sprouting by a few days, as is to be expected. The pruning of lateral roots appears to have delayed sprouting, while the treatment with Hortomone may have slightly hastened sprouting.

(2) *Deaths.*—Only 3 stumps out of the total of 240 died, and these were all plants which had the lateral roots removed. The difference might be accentuated under field conditions if the weather were unfavourable.

(3) *Growth of shoot.*—Hortomone, applied in this manner, has been ineffective.

(4) The removal of lateral roots has significantly retarded growth.

(5) Ring-barking the stock prior to transplanting has shown no advantage.

(6) There is an indication of slightly better growth where the lateral roots were cut in the nursery 14 days before planting, but in commercial practice this procedure would be troublesome.

(7) The growth has been significantly better on large than on small stocks.

It may be noted that the early growth of these plants was slow owing largely to the fact that they were planted only a few weeks before the severe drought of January/February, 1939.

A further experiment was started in December, 1939, to determine :

(1) The value of immersion of the tap root in Hortomone A before planting budded stumps.

(2) The extent to which the lateral roots may be cut without retarding growth.

3. Stock-Scion Relationship

(1) In preparation for an experiment to compare the performance of various clones on stocks raised from illegitimate clonal seedling families, beds of seedlings from the following clones were established at Nivitigalakele :—TJ. 1, TJ. 16, B.D. 10, A.V.R.O.S. 163, B.R. 2, MK. 3/2, MK. 1/1, MK. 1/3, B.S. 3, HC.28, W. 259, W. 320, HC. 54, unselected (control). Measurements of growth and observations on types of root system will be made periodically.

(2) Forty-eight pairs of " twinned " seedlings, divided equally between clones B.R.2 and HC.55, were planted in the 1939 Kosgahahena clearing. One member of each pair will be budded in due course and information obtained on the influence of stock on scion and scion on stock. Further " twins " of these and other clonal families have been planted elsewhere and will remain unbudded.

(3) Arrangements were completed to lease a small block of land on Mukalana Estate on which buddings of TJ.16 and B.D. 5 were made in 1931 at a height of 5 ft. An experiment will be commenced early in 1940, tapping these trees on both stock and scion, and data thus obtained on the effect of the yield of the stock on that of the scion. Since there are also a certain number of unsuccessfully budded plants which were cut back at the same level, some indication will be obtained as to whether either of these clones has favourably influenced the yield of the stock.

4. Studies on Clones

(1) *Clone Trials.*—A new clone trial area was established in a clearing of about 10 acres at Nivitigalakele, 44 clones were planted as budded stumps, their origin being as follows :—

New clones from Tjikadoe seedlings	29
New clones from marcots (Nivitigalakele)	3
New clone from estate mother tree	1
Promising local clones being tested elsewhere under unsuitable conditions	3
" Proved " local clones (MK. 3/2, WG 6278, B.S.3, D.B.K. 1)	4
" Proved " imported clones (TJ. 1, TJ. 16, P.B. 86, G. 1) ...	4
	44

The clones are distributed in 20 randomised blocks, a single tree comprising a unit plot. This lay-out will give an accurate comparison between the clones though it has the disadvantage that a weak-growing clone may suffer unfairly from competition with stronger-growing neighbours.

Arrangements have been made for some of the best local clones to be planted in test plots of approximately one acre on estates in different districts, the object being to study their performance under a range of climatic and soil conditions. One such area was planted with budded stumps (and illegitimate seedling progeny) of Clones MK. 3/2, WG 6278, DBK.1, B.S.3 and TJ.1 during the year, and arrangements have been made to supply budwood to two estates for field budding in 1940.

(2) **Yield Records**

(*a*) *Ceylon Clones.*—Test-tapping of Ceylon clones has been continued at Nivitigalakele, Wagolla and on various estates co-operating with the Scheme. The present procedure at Nivitigalakele is to discontinue the special recording of any clone which does not show promise after three years of test-tapping. The yield figures for 1939 are not available for inclusion in this Report, but it may be mentioned that a feature of the results at Nivitigalakele has been the satisfactory increase shown by Clone MK. 3/2. The 10 test-tapped trees gave an average yield of 15.6 lb. for 119 tappings at 9 years old.

The testing of certain Ceylon clones has now reached a stage at which it is desirable for budwood to be distributed to estates so that rapid multiplication may be effected if and when further results justify their commercial use. Budwood of 14 such clones has accordingly been multiplied in the Nivitigalakele nurseries, 3 of which were distributed to a number of estates towards the end of the year.

(*b*) *Imported Clones.*—In addition to test-tapping records of small groups of trees, figures relating to the commercial or semi-commercial tapping of imported clones are now being received from several estates. The results will be published in the Quarterly Circular in due course, and here it may be stated that in general they confirm the indications given by the test-tappings.

5. Exchange of Clones

Ten new clones developed by the Rubber Research Institute of Malaya were received in exchange for 7 of the best Ceylon clones. Arrangements have also been made for an exchange of clones with the Proefstation West Java and the A.V.R.O.S. Proefstation, Sumatra, early in 1940.

B. **Breeding Investigations**

During the 1939 flowering season 2,565 artificial pollinations were made, mostly between buddings of high-yielding Ceylon clones. Clone Pilmoor A.44, which is established in a clone trial area at Nivitigalakele, was also used as a parent, and pollen of TJ.1 was brought in from a neighbouring estate for a few crosses.

The full results are given in Table 11. 108 fruits were harvested, representing 4.2% successes. The percentage of germination was rather disappointing and only 199 seedlings were raised. The germination was particularly poor with seed of which WG. 6278 was the mother, the same experience being encountered with illegitimate seed of this clone. The seedlings were planted in a nursery and will later be transferred to the field as stumps.

It will be noted that only 1 fruit was obtained from 1,182 pollinations using MK.3/2 as female parent, and no success at all from 327 pollinations on HC 28. This is thought to be due to the branches being insufficiently exposed to light and air and this mistake will be avoided in future work. If these two clones are excluded the percentage of successful pollinations reaches the satisfactory figure of 10.1.

This work will be continued in future years, the aim being to obtain 25 plants of each cross.

A memorandum was submitted to the Board recommending the early establishment of seed gardens with the clones used in this artificial pollination work so that commercial sources of seed will be available if and when the experimental results justify its use.

C. Cytogenetics

Dr. Ford has devoted considerable attention to methods of technique for the study of mitotic and meiotic nuclear divisions. A thoroughly satisfactory technique for rapid observation of mitosis has been developed in the form of root tip smear preparations. An exact count of the number of chromosomes is difficult owing to their very small size, but it will be possible to distinguish with certainty between polyploids and the normal diploids and it is hoped that occasional certain counts will be obtained. The presence of " prochromosomes " will also help in counts.

Certain difficulties have been encountered in the preparation of meiosis in pollen mother cells both by the smear and paraffin section method, but it is hoped that these will be overcome when fresh flowers are available.

It has recently been discovered that natural twins occur among the seedlings of many crop plants and that one member of such a pair is often polyploid, i.e. the cell nuclei contain a multiple of the normal number of chromosomes. Such polyploids are often of commercial value as " giant " varieties, i.e. they have increased cropping potentialities. In 1938 and 1939 nine pairs of natural twins were found but so far no polyploidy has been discovered.

D. Bark Anatomy

Work has been commenced on a study of bark anatomy in relation to yield, attention being so far mainly directed towards an appreciation of the variables involved and the development of a sound technique. The Geneticist's Field Assistant is being trained to make satisfactory preparations and observations.

TABLE II

Summary of Crosses made in 1939

Family	No. of Pollinations	No. of Fruits set	No. of Fruits harvested	Percentage of success	No. of seeds planted	No. of Seeds germinated	Percentage of germination
MK. 3/2×WG. 6278 ...	313	1	1	0·3	3	3	100
MK. 3/2×BS. 3	305	0	0	—	—	—	—
MK. 3/2×H.C. 28	310	0	0	—	—	—	—
MK. 3/2×Pil. A. 44... ...	246	0	0	—	—	—	—
MK. 3/2×TJ. 1	8	0	0	—	—	—	—
HC. 28×MK. 3/2	254	0	0	—	—	—	—
HC. 28×WG. 6278	67	0	0	—	—	—	—
HC. 28×BS. 3	6	0	0	—	—	—	—
Pil. A. 44×BS. 3	295	17	6	2·0	18	16	89
Pil. A. 44×MK. 3/2... ...	135	7	3	2·2	9	6	67
Pil. A. 44×WG. 6278 ...	194	39	9	4·6	27	21	78
Pil. A. 44×TJ. 1	6	1	0	—	—	—	—
BS. 3×MK. 3/2	123	32	29	23·6	87	52	60
BS. 3×WG. 6278	131	37	29	22·1	87	55	63
BS. 3×Pil. A. 44	90	21	15	16·7	45	40	89
BS. 3×TJ. 1	2	1	1	—	3	3	100
WG. 6278×MK. 3/2 ...	68	21	15	22·1	45	3	7
WG. 6278×TJ. 1	12	1	0	—	—	—	—
All families	2565	178	108	4·2	324	199	62

TABLE III

Tapping Experiment. Adjusted Yields as Percentage of System No. 1

	Tapping Systems*	1937/38	1938/39	1937/39
Sub-Block A Two/Four Day Series	1. ½S,a.d. (2 × 6m), 100%	100·0	100·0	100·0
	2. ½S,a.d. 12/6m, 67%	70·8	74·0	72·3
	3. ½S,a.d. (2 × 2d), 100%	110·4	108·6	109·5
	4. ¼/¼S,a.d. 100%	85·0	94·5	89·8
	5. 2/2S,4d,100%	96·8	105·7	101·2
	6. 2/2S,4d, 12/6m, 67%	73·2	74·2	73·6
Sub-Block B Three Day Series	7. ½S,3.d. 67%	67·8	71·2	69·4
	8. 2/2S,3.d. 133%	112·3	111·6	111·9
	9. 2/2S,3.d, 6/6m, 67%	69·0	73·6	71·3
	10. 2/2S,3.d., 12/6m, 89%	75·8	77·6	76·7
	11. 2/2S,3.d. 8/4m, 89%	81·0	89·0	84·9
	Standard Error	3·4	3·8	3·3
	Sig. Diff. (·05) *within* sub-blocks	9·5	10·8	9·5
	Ditto *between* sub-blocks	10·5	10·5	9·7

*Standard International Notation is used (see Quarterly Circular, Vol. 16, Parts 3 and 4).

TABLE IV

Tapping Experiment. Thickness of Renewing Cortex in Millimetres

Tapping System	March, 1938 (13 Mths.)	March, 1939 (25 Mths.)	Increase 1938/39
1. ½S,a.d, (2 × 6m), 100%	5·8	6·6	0·8
2. ½S,a.d, 12/6m, 67%	5·8	6·9	1·1
3. ½S,a.d. (2 × 2d), 100%	5·9	6·8	0·9
4. ¼/¼S,a.d, 100%	5·9	6·6	0·7
5. 2/2S,4d, 100%	6·0	6·7	0·7
6. 2/2S,4d, 12/6m, 67%	5·9	6·9	1·0
7. ½S,3.d, 67%	5·9	6·6	0·7
8. 2/2S,3.d, 133%...	5·8	6·8	1·0
9. 2/2S,3.d, 6/6m, 67%	5·9	6·8	0·9
10. 2/2S,3.d., 12/6m, 89%...	5·9	6·9	1·0
11. 2/2S,3.d, 8/4m, 89%	6·0	6·6	0·6
Mean	5·9	6·7	0·8
			Differences not significant

Problems Connected with Mature Areas

A. Tapping

1. *Mature Seedling Trees*

(*a*) *Experiment on Dartonfield.*—The experiment on Dartonfield, in which eleven different systems of tapping are under comparison, completed its second year (excluding the preliminary uniformity trial) in February, 1939. The results for the first two years were published in Quarterly Circular, Vol. 16, Part 2, and the following notes summarise the results of main interest :

Yield.—Table III summarises the results for the two years separately and together, the yields being expressed as a percentage of System No. 1. The figures have in all cases been corrected by means of a regression on the results of the uniformity trial carried out in 1936-37.

The abbreviations for the several tapping systems conform to the new standard international notation of which details are given in Quarterly Circular, Vol. 16, Parts 3 and 4. For a full description of the systems the reader is referred to the paper published in Quarterly Circular, Vol. 16, Part 2.

It will be observed that the less intense systems of tapping have given little more than their theoretical yield during the first year (1937/38), but they all show a relative increase in the second year. This indicates that the trees have derived a benefit from the periodic rest or increased interval between tappings.

The increased yield obtained by System No. 3, which involves tapping the tree on alternate days but on alternating sides, is interesting and just on the border line of statistical significance. Another interesting and rather unexpected result is the maintenance of the increased yield from the " double-three " plots (No.8). The dry rubber content from these trees also remains at a satisfactory level.

Bark Renewal.—The figures for the thickness of the renewed bark 13 and 25 months after tapping are given in Table IV. (The slight discrepancy between the figures given for March, 1938, and the corresponding measurements given in the Annual Report for 1938 is due to a correction for the use of a different bark gauge). None of the differences is significant, and it must be concluded that under the conditions of the experiment the various systems of tapping have had no differential effect on the rate of renewal.

(*b*) *Slaughter-Tapping Experiment.*—In September, 1938, a large scale experiment was commenced on an estate with the object of determining the best means of " slaughter-tapping " trees prior to replanting, the period being approximately a year. The Research Scheme was consulted regarding the design of the experiment and the most suitable treatments for trial, and the suggestions made were fully carried out.

Lay-Out.—The eight treatments were arranged in six randomised blocks, each plot comprising a tapper's task of 210 trees. Where the trees were tapped on two cuts, however, the tapper's task was halved.

Treatments.—The experimental period was divided into two portions of approximately five months each, separated by a month during which the trees were rested for the " winter." The treatments during these two periods are given in Table V.

TABLE V

Slaughter-Tapping Experiment

Period	4/9/38-4/2/39	6/3/39-14/8/39
Treatment 1 ...	½S,a.d.100% ...	½S,a.d.100% on opposite panel
,, 2 ...	½S,a.d.100%* ...	½S,a.d.100%* on opposite panel
,, 3 ...	½S,a.d.100% ...	2/2S,a.d.200%*
,, 4 ...	½S,a.d.100%* ...	2/2S,a.d.200%*
,, 5 ...	2/2S,3.d.133% ...	2/2S,3.d.133%
,, 6 ...	2/2S,3.d.133%* ...	2/2S,3.d.133%*
,, 7 ...	2/2S,3.d.133% ...	2/2S,a.d.200%*
,, 8 ...	2/2S,3.d.133%* ...	2/2S,a.d.200%*

Notes (1) The Standard International Notation is used. (See Quarterly Circular, Vol. 16, Parts 3 and 4).

½S,a.d. = half-spiral on alternate days

2/2S,3.d. = " double-three "

2/2S,a.d. = " double-two "

(2) *denotes extra deep tapping with bark consumption limited only by reserves present.

It will be noted that only three methods of tapping were employed (disregarding the extra hard tapping), and the experiment mainly comprises a study of the yield on the " double-two " system following after half-spiral alternate day and " double-three " tapping.

Results.—Table VI gives the yields in terms of lb. per acre and percentage of Treatment 1 for the first and second periods separately and together. It also indicates what differences may be judged significant on the conventional basis of a 20: 1 chance. The figures refer to total yields, i.e. including scrap, and an analysis shows that there are no appreciable differences in percentage scrap for the various treatments.

Conclusions.—The following conclusions must be qualified by two considerations: (*a*) The double-cut systems are somewhat favoured as regards yield per

tree owing to the tasks being relatively small, for it does not take as long to tap 210 cuts on 105 trees as 210 cuts on 210 trees.

(*b*) The proportionate yield of Treatments 3, 4, 7, and 8 would have been slightly higher over the whole period had the period of " double-two " tapping included some of the best yielding months.

(1) Comparing Treatments 1 and 2 for the whole period and 3 and 4 for the first five months, there is an indication that on $\frac{1}{2}$S. a. d. extra deep tapping with unlimited bark consumption gives a small additional yield though the difference is not significant.

(2) A similar comparison with Treatments 5, 6, 7 and 8 indicates that with 2/2S. 3.d. tapping, on the other hand, there is a tendency for the hard tapping to reduce the yield. This might be due to the ringing effect of extra depth on both sides of the tree. For the second period 8 is significantly lower than 7, again suggesting the harmful effect of the extra deep tapping in the previous period.

(3) Comparing 5 and 7 with 1 and 3 for the first period, the additional yield on the " double-three " tapping does not differ significantly from the theoretical expectation of 33%. On continuing 5 into the second period after a month's rest, it shows a slightly decreased yield but still near the theoretical 133%. The satisfactory maintenance of yield on this system without any rest (except for wintering) is also a feature of the tapping experiment on Dartonfield.

(4) Comparing 3 and 4 with 1 in the second period, it would seem that " double-two " tapping gives about an 80% increase for five months (after a month's rest). The comparison of 7 with 1 shows that this is also the case after 5 months' " double-three " tapping, but 8 gives only a 56% increase after " double-three " hard tapping.

(5) The highest yield has been given by Treatment 7 (51% increase over control).

(6) Although the d.r.c. of the latex under the " double-two " tapping fell to 3 lb. 2 oz. per gallon during the last six weeks as compared with 3 lb. 12 oz. per gallon for Treatment 1, an analysis of the monthly figures does not show any tendency towards a decrease in yield relative to the control. This is rather unexpected and suggests that " double-two " tapping could be profitably continued for longer than 5 months.

In general the experiment has shown that under the particular local conditions (which are not abnormal in any respect) the trees can be tapped rather more severely than had been anticipated. The intervening one month's rest doubtless exercised an influence in this respect.

TABLE VI

Slaughter-Tapping Experiment.

Yields (including scrap) expressed as :

(*a*) lb. per acre

(*b*) percentage of Treatment 1

Period	4/9/38-4/2/39		6/3/39-14/8/39		4/9/38-14/8/39	
Treatment	(*a*)	(*b*)	(*a*)	(*b*)	(*a*)	(*b*)
1 ...	283	100·0	209	100·0	492	100·0
2 ...	296	104·7	217	103·7	513	104·2
3 ...	270	95·4	362	173·6	632	128·6
4 ...	302	106·8	391	187·2	693	141·0
5 ...	395	140·0	275	131·9	670	136·7
6 ...	375	132·6	273	130·7	648	131·9
7 ...	371	130·9	373	178·5	744	151·1
8 ...	368	130·0	326	155·9	694	141·0
Mean ...	332	117·5	303	145·2	635	129·3
Standard Error ...	11·4	4·05	11·4	5·41	23·4	4·81
Significant Difference (P. = ·05) ...	31	11·2	31	15·0	65	13·3

2. Young Budded Trees

(*a*) *Experiments on Estates.*—Four tapping experiments in budded areas of imported clones were commenced during the year, and the results up to the end of 1939 are summarised in Table VII.

In each case a tapper's block comprises the unit plot though the size varies somewhat in the different experiments. Experiments 1, 2 and 3 are replicated four-fold but Experiment 4 has no replication within each clone.

An interesting feature of the results to-date is the satisfactory yield obtained on a third spiral on alternate days. In every case where a comparison is made with third daily tapping on a half-spiral the yield is appreciably higher on the former system though the relative intensities of tapping are the same.

Up to the present there is no indication of significant yield differences between Systems 1, 4 and 5 which are all of equal intensity.

Observations are also made on dry rubber content, percentage of scrap, incidence of Brown Bast, etc., and the results will be published in further detail in due course.

(*b*) *Rate of Bark Consumption.*—An experiment was started at Nivitigalakele in April, 1938, to shed light on the optimum rate of bark consumption for maximum crop when tapping young budded trees on the half-spiral alternate day system.

TABLE VII

Tapping Experiments with Budded Trees. Yield in lb. per acre (total rubber) for period stated and percentage comparison with ½S, a. d. (Figures in brackets denote number of tappings).

Expt No.	Clone	Locality	Year budded or planted	Acres	Period of tapping	1 ½ S,a.d.100% Initial Height of Cut/s (inches) 34 Yield lb.per acre	1 per cent	2 1/3S,3.d.67% 24 Yield lb.per acre	2 per cent	3 ½ S,3.d. 67% 26½ Yield lb.per acre	3 per cent	4 2/2S,4d.100% 39 & 21½ Yield lb.per acre	4 per cent	5 1/1S,4d.100% 21½ Yield lb.per acre	5 per cent
1	TJ. 1 ...	Kalutara and Ratnapura ...	1931/32	34	9 mths.	506 (113)	100	448 (113)	89	414 (77)	82	510 (56)	101	499 (56)	99
2	B.D. 5 ...	Kalutara ...	1931/32	20½	9 ,,	389 (120)	100					380 (60)	97	394 (60)	101
3	TJ. 16 ...	Ratnapura ...	1931/32	21	5 ,,	275 (50)	100					263 (25)	96	262 (25)	95
4	TJ. 1 ...	Elpitiya ...	1931	5·3	12 ,,	616 (158)	100	514 (157)	83	443 (104)	72				
	AVROS 49...			5·8		588 (156)	100	499 (156)	85	356 (104)	61				
	B.D. 5 ...			3·6		467 (158)	100	375 (157)	80	305 (103)	65				

Notes (1) The yields refer in all cases to the first year (or portion thereof) of tapping.
(2) The acreages given are divided equally among the systems of tapping under trial.
(2) The initial heights of cuts in Expt. No. 4 were slightly in excess of those given.

Eight Ceylon clones are used for the experiment, four trees of each clone being subjected to each treatment. The experiment was planned to run for two years, differences in height of cut being equalised by inter-changing the trees in Treatments 1 and 3 after one year.

The results for the first 21 months are given in Table VIII.

TABLE VIII

Bark Consumption Experiment

Treatment	Consumption per month	Approx. number of shavings per inch	Yield as percent. of Treatment 1
1	$\frac{1}{2}$ inch	25	100·0
2	$\frac{3}{4}$ "	16·7	95·6
3	1 "	12·5	101·4

The treatment effect is not significant, so it would appear that there is no advantage in a higher rate of consumption than corresponds to 25 cuts to the inch. At the same time there is always some doubt as to whether the results of a small scale experiment of this nature are entirely applicable to commercial estate work for in practice the standard of tapping might not be so uniformly high. The more regular the thickness of the shaving the thinner need it be to obtain the maximum flow.

B. Cover Crops

General.—In the Annual Report for 1938 it was stated that " the resumption of manuring programmes has facilitated the establishment of leguminous ground covers on estates, and it is probably true to say that most estates now carry a satisfactory cover in their mature areas. The species most commonly planted is *Pueraria phaseoloides*." This year it is unfortunately necessary to report that on many estates, particularly in the Kelani Valley, the cover of Pueraria has greatly deteriorated and in certain areas completely disappeared. The subject is dealt with in the pathological section of this report, and it would seem that the cause of death—or at least a contributory factor thereto—is " legume sickness " which is associated with growth on the same land for more than a certain number of years. The development of this phenomenon in such a striking form opens the question as to whether it is desirable to establish and attempt to maintain a ground cover of a single leguminous species. No attempt will be made to answer this question here, but it may be observed that *Centrosema pubescens*, though usually more difficult to establish in mature fields than Pueraria, appears to be of a more permanent nature.

Natural Covers.—Reference has been made in previous reports to an area of 20 acres of 1910 Rubber on Dartonfield in which natural covers have been allowed to develop since the beginning of 1936. No leguminous cover has been planted, though a sparse cover of Vigna remained from an earlier planting.

During the first two years no control measures were undertaken apart from the periodical removal of certain grasses and the thinning of the fern *Blechnum orientale*, which grew very densely in parts of the field. In 1938 all erect covers growing in a belt 6 ft. wide down each row of trees were twice cut to ground level, and a similar treatment was necessary once in 1939. Low cover was maintained in these strips. In addition, all woody erect plants were pruned at a height of 3 ft. once in 1939.

With the object of hastening the tempo of the regeneration process the whole area was forked and manured with a nitrogen-phosphate mixture early in 1938.

A gradual change in plant associations has taken place during the past year or two, partly on account of selective weeding and partly owing to the operation of " natural " selection. An example of the former is the gradual replacement of grasses by more desirable types of vegetation. *Lophatherum gracile*, for instance, which was mentioned in the Annual Report for 1938, has been almost entirely eradicated. The most striking example of the natural selective process is the almost complete elimination of certain Compositae, *e.g. Emilia javanica* (S. Kadupara), *Gynura crepidioides*, *Ageratum conyzoides* (S. Hulantala), whose presence was recorded in 1936.

The constitution of the flora varies to some extent in different parts of the field. In the low-lying portions the predominant species are :—Rubber seedlings, Vigna, *Hedyotis fructicosa* (S. Weraniya), *Cyclea Burmanii*, *Osbeckia octandra* (S. Hin-bowitiya), *Melastoma malabathricum* (S. Maha-bowitiya), *Mussaenda frondosa* (S. Val-butsarana), *Macaranga peltataae* (S. Kenda), *Desmodium heterophyllum* (S. Maha-undupiyali), *Pandanus tectorius* (S. Mudu-keyiya), and grasses.

Higher up the hill the following species are particularly noticeable in addition to some of the foregoing :—*Hedyotis auricularia* (S. Geta-kola), *Schizaea digitata* (S. Parsi), *Blechnum orientale*, *Dryopteris amboinense*, *Dilenia retusa* (S. Godapara), *Glochidion Zeylanicum* (S. Hunu-kirilla), *Cyperus uncinatus*, *Tetracera scandens* (S. Korasa), *Ziziphus oenoplia* (S. Hin-eraminiya), *Syzygium caryophyllatum* (S. Dan), *Vitex pinnata*, and a plant known by the local Sinhalese as Kappung-kire (the sticks are used for goading bulls).

It is interesting to compare the yield of this area since the commencement of the trial with that of the whole estate, and the figures are given below :—

	Whole Estate	" Forestry " Block
1936	... 575 lb. per acre	... 653 lb. per acre
1937	... 600 „ „	... 609 „ „
1938	... 593 „ „	... 580 „ „
1939	... 542 „ „	... 575 „ „

The general trend of these yields suggests that whereas in the earlier stages of regeneration the competition between the cover and the trees had a deleterious effect on yield, the position has now been reached where the improved type of vegetation is exercising a beneficial effect. In the absence of any controlled comparison, however, this suggestion must be accepted with reserve. It should be mentioned that over the rest of the estate a cover of Pueraria was established in 1936/37, and that all fields have received two applications of manure during the four-year period as compared with only one in the " forestry " block.

C. Replanting.

The manuring of replanted clearings now comes within the purview of the Soil Chemist, but all other aspects of replanting are still dealt with by the Botanical Division. The results of the replanting experiments on Dartonfield, excluding manurial comparisons, are summarised below.

Experiment No. 1, 1934 Clearing ($7\frac{1}{2}$ *Acres*).—This area was replanted with budded stumps in June, 1934, the purpose being to compare: (1) methods of disposal of the old timber, (2) species of ground cover crops, and (3) methods of controlling the ground cover. Three blocks are planted respectively with clones Glenshiel 1, A.V.R.O.S. 256 and Prang Besar 25. The mean girth measurements for the various experimental treatments in 1936, 1937, 1938 and 1939 and the increments during the year 1938-39, are given in Table IX.

TABLE IX

Budded Stumps Planted, June, 1934

Girth in inches at 3 ft. from Union

Treatments	1936 Age 2 Yrs.	1937 Age 3 Yrs.	1938 Age 4 Yrs.	1939 Age 5 Yrs.	Increase 1938-39
Species of Cover—					
1. *Centrosema pubescens* ...	5·16	8·93	13·40	17·29	3·89
2. *Pueraria phaseoloides* ...	4·95	8·61	13·56	17·86	4·30
3. *Calopogonium mucunoides* ...	5·51	9·36	13·83	17·69	3·86
4. *Dolichos Hosei* (Vigna) ...	5·43	9·66	14·49	18·48	3·99
Mean	5·26	9·14	13·82	17·83	4·01
Standard Error	—	0·19	0·18	—	0·09
Sig. Diff. (P.= ·05) ...	Not significant	0·64	0·61	Not significant	0·30
Timber Treatments—					
A. Leaving all main stems lying unburned	5·38	9·38	14·06	18·08	4·02
B. Burning all timber on the land	5·19	9·16	13·94	17·99	4·05
C. As B, but also removing and burning all larger lateral roots	5·22	8·88	13·46	17·42	3·96
Mean	5·26	9·14	13·82	17·83	4·01
Differences		Not significant			
Control of Cover—					
X. Keeping platforms clean weeded	5·30	9·17	13·76	17·64	3·88
Y. Ring-weeding in 6 ft. diameter circle	5·22	9·10	13·88	18·01	4·13
Mean	5·26	9·14	13·82	17·83	4·01
Differences		Not significant			

Owing to an increase in the error value there are no significant difference in 1939 corresponding to the various cover crops though Vigna still heads the list. The increase in girth for 1938-39, however, is significantly greater in the Pueraria plots than elsewhere, and this confirms the tendency shown in the previous year.

Whereas the covers of Pueraria and Centrosema remain thick and healthy Vigna and Calopogonium have become much thinner under the increased shade cast by the trees. The latter, in particular, has almost disappeared in places and the plots will have to be replanted with some other species if soil erosion is to be prevented.

None of the other treatment differences is significant.

Two further cases of root disease occurred during the year, one *Fomes lignosus* and the other *Poria hypobrunnea*, bringing the total for this clearing to five. They have all occurred in areas in which the lateral roots were left in the ground, suggesting the efficacy of the preliminary root removal (Treatment C) in eradicating sources of infection.

Experiment No. 3, 1936 Clearing (9½ Acres).—The following series of comparisons are being made in this area :—

Methods of Opening—

1. Planting on contour platforms.
2. Planting in contour trenches.
3. Contour planting, with level pitted drains between the contours.

Methods of Planting—

A. Planting budded stumps (Planted May, 1936).
B. Planting stumped buddings (Planted May, 1936).
C. Planting one basket plant and four germinated seed in each hole for subsequent budding in the field. (Planted September, 1936, and mostly budded November-December, 1937).

Manuring—

X. A complete inorganic mixture.
Y. A complete organic mixture.

Measurements of girth were made in June and the figures for 1938 and 1939 are given in Table X.

TABLE X

Girth in Inches at 3 ft. from Union

Treatment	1938 Age 2 Years	1939 Age 3 Years	Increase 1938-1939
Methods of Opening—			
1. Contour platforms		8·99	
2. Contour trenches	See footnote	8·87	See footnote
3. Contour drains		8·07	
Mean		8·64	
Standard Error		0·20	
Sig. Diff. (P. = ·05)		0·69	
Methods of Planting—			
A. Budded stumps	6·21	9·19	2·98
B. Stumped buddings	8·55	11·84	3·29
C. Field buddings	—	4·89	—
Mean		8·64	
Standard Error		0·27	
Sig. Diff. (P. = ·05)		0·79	

Note.—It is not possible to give figures for 1938 for methods of opening owing to the fact that in that year the field buddings were measured as to height and not as to girth.

Methods of Opening.—There is no significant difference between the growth on the contour platforms and in the trenches, but both are significantly better than the pitted drains.

Methods of Planting.—As is to be expected at this stage the stumped buddings are substantially bigger than the budded stumps, and the increase during the year 1938-39, though rather disappointing in both cases, is also superior. The field buddings are naturally much smaller, and it will be interesting to compare the first girth increment figure (in 1940) with the similar increments for the other types of material at the corresponding stages of development.

Organic *vs.* Inorganic Manuring.—See Soil Chemist's Report.

MISCELLANEOUS

Handbook of Rubber Planting.—At the request of Government a handbook, giving instructions on the opening and planting a land with Rubber and subsequent upkeep of the clearings, was prepared for issue by the New Rubber Planting Scheme. The compilation of this handbook necessitated a number of conferences with the Chief Advisory Officer to this Scheme.

Characteristics of Ceylon Clones.—The vegetative characteristics of the more important Ceylon clones were studied and described with a view to the issue of a publication early in 1940.

ADVISORY WORK

Identification of Clones

The identification of clones on estates by the officers lent by the Rubber Research Institute of Malaya, to which reference was made in the Report for 1938, was completed early in 1939. In all, 138 estates were visited, and an analysis of the results is given in a report published in Quarterly Circular, Vol 16, Part 2. Visits were also paid to 13 estates by the Conductor, Nivitigalakele, for the same purpose.

Visits to Estates

The following vists were paid to estates (excluding visits to Nivitigalakele):—

Officer	Advisory	Experimental
R. K. S. Murray	39	18
C. A. de Silva	1	—
C. E. Ford	1	14
	41	32

Specimens and Enquiries

The volume of advisory work, as reflected by the number of specimens and enquiries, shows a considerable reduction on last year's figures. This is partly accounted for by Mr. Murray's absence for three months and partly by the fact that most of the enquiries on the subject of manuring are now dealt with by the Soil Chemist.

Specimens were received for report from 141 estates as compared with 175 in 1938. The only special feature about these specimens is the relatively large number of Pueraria plants sent for examination in connection with die-back.

Enquiries were dealt with on the following subjects (figures for 1938 in brackets):—

Botanical—				
Planting material...	112	(331)		
Budding procedure and after treatment ...	44			
Replanting procedure	40	(64)		
New planting	21			
Seed gardens	3			
Nurseries	6	(19)		
Manuring	25	(102)		
Cover Crops	45	(36)		
Tapping	17	(13)		
Miscellaneous	16	(34)	329	(599)
Pathological—				
Oidium and sulphur dusting	43	(52)		
Root disease	21	(17)		
Cockchafer grub...	13			
Miscellaneous	39	(62)	116	(131)
Total ...			445	(730)

As mentioned earlier in this report, a number of pathological enquiries and specimens received during Mr. Murray's absence on leave were referred to the Plant Pathologist, Department of Agriculture.

Copies of planting memoranda were issued as follows:—

Notes on budgrafting procedure	30
Contour lining, holing and filling, cutting of platforms, trenches and drains	22
Notes on rubber seedling nurseries	44
Notes on the care of budded trees of Clone Tjirandji 1 with special reference to wind damage	28
Smallholdings Department Leaflet No. 1 (Revised September, 1938)	5
Root disease in replanted areas	3

Correspondence amounted to 1,351 inward and 1,525 outward letters.

VISITORS

Personal interviews with visitors constitute a useful feature of advisory service, but the number of visitors to the botanical laboratories, as distinct from visitors to the estate and head office, has not been recorded.

PUBLICATIONS

Ceylon Clones—VII (1938—Quarterly Circular, Vol. 16, Part 1. C. E. Ford.

Field Experiments on Dartonfield Estate—VIII—Manuring Experiment with Mature Rubber.—Quarterly Circular, Vol. 16, Part 1. L. A. Whelan and C. A. de Silva.

Field Experiments on Dartonfield Estate—IX.—Comparison of Tapping Systems.—Quarterly Circular, Vol. 16, Part 2. R. K. S. Murray and C. A. de Silva.

The Performance of Imported Clones in Ceylon—III—Quarterly Circular, Vol. 16, Part 2. C. E. Ford.

Oidium Leaf Disease in Ceylon in 1939.—Quarterly Circular, Vol. 16, Part 2. R. K. S. Murray.

Identification of Clones on Ceylon Estates.—Quarterly Circular, Vol 16, Part 2. R. K. S. Murray.

Field Experiments on Dartonfield Estate—X.—Measurements of Growth in Replanted Areas.—Quarterly Circular, Vol. 16, Parts 3 and 4. L. A. Whelan and C. A. de Silva.

Handbook of Rubber Planting (Ceylon). R. K. S. Murray (in the Press).

(Sgd.) R. K. S. MURRAY,
Botanist and Mycologist.

Research Laboratories,
Dartonfield, Agalawatta.
20th January, 1940.

REPORT OF THE SOIL CHEMIST FOR 1939

The department was formed on the appointment of the writer as Soil Chemist in November, 1938, and this report covers the work carried out during 1939.

STAFF AND ORGANISATION

At the beginning of the year work pertaining to manuring and soil management both of an advisory and experimental nature, which had previously been under the control of the Botanist, was taken over by the Division. The valuable practical knowledge of officers in the Botanical Department has frequently been called on during the year particularly in matters of a controversial nature and of major importance.

Certain problems of manuring and of soil management can best be tackled by joint action by the two departments and a policy of close collaboration between Botanist and Soil Chemist is regarded as essential.

During the year the Assistant Botanist has continued his supervision of all field manurial experiments on Dartonfield and Nivitigalakele laid down before the Division was constituted.

Mr. P. Tharmalingam, B.Sc., was appointed Analyst to the Division in January, 1939. As his experience of the methods used in a Soils Laboratory increases it is intended that more of the responsibility for this branch of the work will be assumed by him.

MANURING

(1) Mature Seedling Trees

(*a*) *General.*—Until more is known of the response of mature rubber on different soil types to the chief plant foods, the Scheme advises the occasional application of potash and phosphate in addition to nitrogen. The general manuring programme recommended is a biennial application consisting alternately of 60 lbs. nitrogen per acre and a mixture containing 60 lbs. nitrogen, 20 lbs. phosphoric acid and 12½ lbs. potash.

Whilst some advantage may be expected to ensue from forking in manure as opposed to broadcasting it is considered that soil disturbance—particularly on steep land—may lead to considerable soil loss and possibly to root damage. For this reason broadcasting is recommended as a general procedure except where more than 20% of the total nitrogen is in the organic form.

As regards the best time for application the Scheme holds the view that provided care is taken not to apply soluble manures at a time of heavy rain or when the tree is defoliated, any differences in growth or yield due to application at different times of year are likely to be small. The February-April period is recommended on the assumption that the tree may make better use of fertilisers just after refoliation and before the coming of heavy rain increases the danger of loss by leaching.

Due to the shortage of sulphate of ammonia in the Island since the outbreak f war the problem of suitable substitutes has assumed importance. The follow- ig figures for the cost per unit of nitrogen of the more common nitrogenous anures will indicate the importance of the price aspect:—

	Per Unit
Sulphate of ammonia (at 23/6/39)	Rs. 6·84
Nitrate of soda (at 31/12/39)	,, 11·36
Groundnut cake (at 31/12/39)	,, 16·15

The Fertiliser Companies are meeting the shortage of sulphate of ammonia y supplying part of the total nitrogen in other forms.

The policy of the Rubber Research Scheme in advising on alternative mixtures as usually been to recommend the use of the cheapest substitute offered with ue regard to certain safeguards in application.

The nitrogen in nitrate of soda is available to the plant as soon as applied, ut some importance may attach to the fact that in soils generally it is more bject to loss by leaching than other forms of nitrogenous manure. If care used in choosing the time for application, this danger may largely be obviated.

Insoluble organic manures (*e.g.*, groundnut cake) are liable to be washed way from the point of application during heavy rain and it is advisable that ey (or mixtures containing more than 20% of the total nitrogen in the rganic form) be forked into the soil in alternate rows.

(*b*) *Experiment on Dartonfield.*—The fourth year of this experiment was ompleted at the end of 1939, but the figures are not available for inclusion in his report. The results for 1938, the year following the second annual applica- ion were reported in a paper in the Quarterly Circular, Volume 16, Part 1, and a summary is given in Table I.

TABLE 1

Treat- ment	Preliminary Year, 1936	Adjusted Yields, 1937	Actual Yields, 1938	Adjusted Yields, 1938	Adjusted Yields, 1938, as % of the Control
N ...	53·4	49·8	57·4	56·9	114
NP ...	52·3	47·5	52·2	52·9	106
NK ...	55·5	49·1	59·0	56·5	113
NPK ...	56·5	49·6	62·7	59·3	119
O ...	47·1	44·8	44·2	50·0	100
Means	53·0	48·2	55·1	55·1	
		Standard Error = 1·2	—	1·8	3·6
		Significant Difference (P. = ·05) = 3·5	—	5·3	10·6

Yield.—The yields have been adjusted by means of a regression on the preliminary figures for 1936. Judged by the conventional standard of a 20 : 1 probability the treatment effect is significant and differences of 5·3 lbs. per plot or more are real. As in the previous year (1937) the yield of the control plots is seen to be significantly lower than that of any of the manured plots except NP. In 1938 the NP plots were also significantly less than the NPK plots. One may conclude that nitrogen alone or with minerals has exercised a beneficial effect on yield, but that on this soil an NP mixture should not be applied without the addition of K.

There was no indication of any difference between the two methods of application, broadcasting and forking. It may be pointed out that owing to the relatively poor growth of cover in plots not receiving phosphate, the original comparison of forking in the fertiliser with Pueraria and other green loppings and broadcasting it over the cover has been modified for the present. The comparison of forking in and broadcasting applies only to the artificial manure, the cover where it occurs being left undisturbed.

Growth Figures.—During the year, growth appears to have been at a standstill judged by both girth increment and bark renewal figures, and the small differences between differently manured plots are not significant.

Future Manuring.—To bring the experiment into line with general estate practice the programme has been altered from an annual to a biennial application at twice the rate. The next application is due in March, 1941.

(2) Young Buddings

(*a*) *General.*—A programme of manuring for young replanted areas has been drawn up and this is revised from time to time. Its main feature is the use of increasing quantities of NPK mixtures with a general NPK ratio of approximately 2. 2. 1.

The additional cost of nitrogenous manuring under present conditions is not as serious as in the case of mature rubber owing to the smaller application to young plants. If some form of economy is desired, it is suggested that the plan of giving normal doses to backward plants and omitting temporarily the manuring of satisfactory plants should be adopted as an alternative to a reduced rate of manuring all round.

(*b*) *Experiment on Dartonfield—Experiment No. 2 (13—6½ Acres).*—This area which was replanted with budded stumps in May-June, 1938, was manured in March, 1939 and again in September. Measurements of height were made in March and September and of girth in September. The results were reported in a paper in the Quarterly Circular, Vol. 16, Parts 3 and 4, and a summary is given in Table II.

The increment figures for the six monthly period indicate a significant increase over the control for the treatments, PK, NPK and compost.

If the compost plots be ignored, the main effects of each nutrient (N, P and K) may be calculated.

TABLE II

Treatment	Mean Height in Inches per Plant						Mean Girth in Inches per Plant at 3 ft. from ground	
	March		September		Increment March/September		September	
	Actual	Increase over O	Actual	Increase over O	Actual	Increase over O	Actual	Increase over O
O	43·6	—	108·8	—	65·2	—	2·81	—
N	47·1	3·5	108·3	—0·5	61·2	—4·0	2·93	·12
P	46·4	3·6	116·7	7·9	70·1	4·9	2·96	·15
K	44·2	0·6	110·3	1·5	66·1	0·9	2·87	·06
NP	40·6	—3·0	104·9	—3·9	64·3	—0·9	2·71	—·10
NK	50·7	7·1	119·2	10·4	68·5	3·3	3·10	·29
PK	46·3	2·7	125·4	16·6	79·1	13·9	3·05	·24
NPK	53·8	9·2	132·0	23·2	78·2	13·0	3·25	·44
Compost...	51·5	7·9	131·1	22·3	79·6	14·4	3·29	·48
Standard Error					4·1			
Significant Difference	Not significant		Not significant		11·8		Not significant	

SUMMARY OF RESULTS

Mean Height of all plants receiving		Effect
No N	70·1 ins.	
N	68·0 „	—2·1 ins.
No P	65·2 ins.	
P	72·9 „	+7·7* ins.
No K	65·2 ins.	
K	72·9 „	+7·7* ins.

Standard Error per Plot 8·37 *Significant at P = ·05

The effect of potash may be further investigated.

Effect in absence of N	Effect in presence of N
+4·9 ins.	+10·6 ins.

Both P and K have significantly increased the height of the young plants and the increase due to K is greater in the presence of N than in its absence though not significantly so.

If the girth measurements are similarly treated only K is found to have had a significant effect and this is greater in the presence of N though not significantly so.

(*c*) *Comparison of Organic with Inorganic Manures—Dartonfield Experiment No. 3, 1936 Clearing, 10 Acres.*—This experiment is described in an article in the Quarterly Circular, Volume 16, Parts 3 and 4.

Manures were applied in April and in September and girth measurements were taken in June.

There was no difference in girth between plants given an organic and those given an inorganic mixture, both having a mean girth of 8·64 ins.

Dartonfield Experiment No. 4 Replanted Area (2 Acres).—This experiment was put down to compare a soluble readily available manure with one less readily available. A third treatment included minor elements over and above those present in the soluble inorganic mixture.

Budded stumps were planted in May. The first application of manure was made in September and a second in November.

The manurial treatments are :—

Control	
Artificial Organics ...	... 2·9 oz. " Black Label Animal Meal " per plant.
Inorganics	... 1·3 oz. nitrate of soda, ·7 oz. concentrated superphosphate and ·3 oz. muriate of potash.
Inorganics plus Minor Elements	... The above inorganics together with small amounts of iron, copper, zinc, copper, manganese, boron and iodine.

Six plants constitute a treatment plot and there are seven replications.

Measurements of height were taken in December and a summary is given elow :—

Treatment	Actual Height in Inches	Adjusted by Regression on September Measurements	Increase over O
)	29·5	28·8	—
norganics	31·3	31·9	3·1
norganics plus Minor Elements ...	32·4	31·1	2·3
Organic	34·3	35·6	6·8
Standard Error	1·13	Significant Difference	3·4

The organic manure has given a significant response over the control and over both the other manurial treatments.

The results which at this stage should be accepted with reserve may be due to some substance present in the organic and not in the other mixtures or to a leaching out of the soluble inorganic nitrogen (nitrate of soda) before the plant could assimilate it.

The experiment is being continued.

Nivitigalakele Experiment.—In this experiment compost purchased from the Kalutara U.D.C. was compared with an inorganic manure mixture of the same NPK content. During 1939 the total quantities of nutrients applied (in two doses, April and September) were 3·12 oz. N, 3·12 oz. P_2O_5 and 2·99 oz. K_2O per tree. The total weight of compost applied, after having passed a 1-inch sieve, was 39·5 lbs. per tree.

Girth measurements were taken in September and show practically no difference between treatments :

Compost	9·94 ins.
Inorganics	10·03 „

It may be pointed out that in both the Dartonfield and Nivitigalakele experiments the comparison includes the addition of green material to both manurial treatments.

(*d*) *Application of Manures to the Planting Hole—Pinnagoda 1939 Clearing (10 Acres).*—Advantage was taken of the 1939 planting for clone trials to superimpose a manurial experiment. The treatments are Control, P, K and PK. Each manurial plot contains 50 plants and there are five replications. The amounts of fertiliser added were 2 oz. muriate of potash for each plant receiving potash 3·5 Saphos for each plant receiving phosphate.

The PK treatment was made up from the above.

The manure was well mixed with the soil in the planting hole to a depth of about 2 feet. Planting with budded stumps was carried out in June just

after addition of the manure and a uniform dressing of 3 oz. sulphate of ammonia per plant was given in November.

Height measurements will be made early in 1940.

(*e*) *Experiments on Estates.*—In 1938 a number of experiments were laid down in different districts. They are mostly of a simple randomised block design with eight treatments of N, P and K at two levels (0 and 1) and with four replications. The measurements for the first year have been received from 12 estates, but only statistically significant responses are given in this brief summary.

Estate 1 (Kalutara District)

Mean Girth in Inches per Plant

(Only three treatments were given in this experiment)

N	NP	NPK
3·11 ins.	3·61 ins.	3·86 ins.

Significant difference ·62 ins.

NPK shows a significant response of ·75 ins. over N alone.

Estate 2 (Kelani Valley District)

Mean Height in Feet per Plant

O	N	P	K	NP	NK	PK	NPK
13′ 1″	13′ 4″	13′ 9″	13′ 9″	13′ 4″	14′ 5″*	11′ 8″*	13′ 5″

Significant difference 15·8 ins.

* NK has produced a significant response and PK a significant depression.

Estate 3 (Kelani Valley District)

The manurial treatments are the same as for estate 2 above. No one treatment has produced a significant effect, but the general response to N averaged over all the other treatments is significant.

Girth in Inches per Plant		Increase
Mean of all plants not receiving N	7·95 ins.	+ ·21
Mean of all plants receiving N...	8·16 „	

Standard error per plot ·203

There is a slight significant response to N, and this is greater in the presence of K, but not significantly so.

(*f*) *General Conclusions.*—There is evidence that the response of Hevea to different plant foods and mixtures varies with soil type and the response may depend to some extent on climate and clone. The influence exercised by these factors may be of considerable importance, and in order to secure as much information as possible the extension of the manurial trial to young budded rubber on other estates would be welcomed.

A number of conclusions have been drawn from the growth measurements taken 12 months after the first application of experimental manure :

(1) The general effect of moderate applications of manure on budded rubber the first and second years after planting is a slight increase in growth.

(2) There are indications that potash (alone or in combination with nitrogen) had a greater effect than phosphate. It is stressed, however, that these ly results should be treated with reserve.

(3) The responses to manures on different estates may appear to be incontent, but it should be pointed out that differences between estates in preperimental manuring, in filling planting holes and in controlling cover may exerting considerable influence at this early stage.

(4) Until further experimental evidence has been obtained it is considered best policy to apply the NPK mixtures given in the " Programme of Manuring Replanted Rubber Clearings " (2nd revision).

Seedling Nursery Plants

(*a*) *Pinnagoda Experiment.*—Seeds were planted in July-August, 1938, and nures given in three applications, in December, 1938, April and July, 1939. each application the manurial treatments were control, single nitrogen (·30 oz. monium sulphate), double nitrogen (·60 oz. A.S.) potash (·12 oz. muriate of ash) phosphate (·33 oz. superphosphate) and all their combinations. There e altogether 12 different manurial treatments and three replications, but the ctive replication of each main treatment was increased by the factorial design the experiment.

The main responses to the different plant foods were :—

Mean Responses to N_1, N_2, P and K Dressings

	May Mean Height per Plant 62·31 ins.	May Mean Diameter per Plant ·64 ins.	August Mean Diameter per Plant ·89 ins.	October Mean Diameter per Plant 1·05 ins.
	Mean response	Mean response	Mean response	Mean response
N_1	+ ·82 in.	+·03 in.	+·02 in.	+·05 in.*
N_2	+2·08 „ *	+·04 „ *	+·04 „*	+·06 „ *
P	— ·14 „	·00 „	—·01 „	—·04 „ *
K	+ ·31 „	+·01 „	+·02 „	+·02 „

* Significant at the 5% level of probability

Height and girth measurements show a small but significant response to rogen and the final girth measurements a small decrease due to phosphate.

On 24th/30th October all plants of 1 1/8 in. diameter or over were budded th Tj. 1. The work of budding was not randomised among the budders

and so the count of successful buddings could not be treated statistically, but the following summary is of interest :—

	Plants without N	Plants with single N	Plants with double N	Plants without P	Plants with P	Plants without K	Plants with K
Plants budded ...	218	269	269	412	344	361	395
Successes	89	213	210	284	228	249	263
Successes as % of plants budded ...	40·8	79·2	78·1	68·9	66·3	68·9	66·6

Application of manures has had only a slight effect on growth, but a small dressing of nitrogen appears to have doubled the number of budding successes.

It is known that food reserves in the neighbourhood of the budded area are depleted after budding and it seems possible that nitrogenous manuring may play an important part in building up such reserves.

(*b*) *Effect of Nursery Manuring on Transplanted Budded Stumps—Nivitigalakele Experiment.*—The experiment was designed to investigate the effect of nursery manuring on date of shooting and subsequent growth of budded stumps. Eighteen successfully budded stumps (of diameter 1 1/8 in. 1 3/8 in.) from each of the manurial plots O, N_2, P, K, N_1K, and N_1PK of the nursery experiment described above were planted out in a gravelly soil previously given a basal dressing of 25 lbs. compost and 3 oz. animal meal per square yard. No further differential manuring will be made during the period of the experiment.

(4) Making of Compost

Nivitigalakele Experiment.—Four heaps of compost were made at Nivitigalakele during the year. Green material was collected in June and stacked without preliminary drying. Each heap contained about one ton raw material and 3½ lbs. calcium cyanamide and 3½ lbs. ground limestone were added to facilitate decomposition. The four heaps were somewhat similar in chemical composition and only mean values are given in this report.

As Percentage of Moist Compost

Moisture (on Drying to 90° C)	Total N	P_2O_5	K_2O
77% ...	·52% ...	·09% ...	·16%

The material in one heap which consisted almost entirely of leaves and small soft stems broke down within three months to a dark loamy compost.

In the other three heaps most of the woody material which was initially present to a considerable extent was still largely undecomposed at the end of five months.

The four tons of green material produced 3,700 lbs. moist compost containing 19·2 lbs. nitrogen (of which 2·7 lbs. had been added as calcium cyanamide), 3·3 lbs. phosphate (P_2O_5) and 5·9 lbs. potash (K_2O). The figures indicate that compost consisting of plant residues without the addition of considerable amounts of cowdung cannot be regarded as a complete manure.

SOIL SURVEY

Up to the end of 1939, 25 profiles have been examined on clearings and in jungle marked for clearing.

From 31 profile pits, 160 soil samples have been taken or sent to the Scheme and it is hoped to make progress in the examination of these during 1941.

LABORATORY WORK

Sixty-nine soil samples were taken or received during the year for advisory purposes and 291 for experimental purposes. In addition eight samples of compost were received, one of drainage water and one of leather scrap. In all, 116 samples were dealt with involving 653 separate analytical determinations.

ESTATE VISITS

The following visits were paid :—

Advisory	8
Experimental	11

CORRESPONDENCE

Enquiries were dealt with on the following subjects :—

Manuring of nurseries	13
Manuring of young budded rubber	48
Manuring of mature rubber	20
Manuring of cover crops	4
Manuring under present war conditions...	37
Time and application of manures...	10
Miscellaneous	24
	156

PUBLICATIONS

The following papers were published :—

1. Field Experiments on Dartonfield Estate—VIII—Quarterly Circular, Vol. 16, Part 1. L. A. Whelan and C. A. de Silva.

2. Field Experiments on Dartonfield Estate—X—Quarterly Circular, Vol. 16, Parts 3 and 4. L. A. Whelan and C. A. de Silva.

MEMORANDA

The "Programme of Manuring for Replanted Rubber Clearings" was revised during the second quarter. Forty copies of the memorandum were despatched to enquirers during the year.

(Sgd.) L. A. WHELAN,
Soil Chemist.

Research Laboratories,
Dartonfield, Agalawatta.
23rd January, 1940.

REPORT OF THE SMALLHOLDINGS PROPAGANDA OFFICER FOR 1939

The present report is a review of the further progress made by the Smallholdings Department of the Rubber Research Scheme, Ceylon, the inauguration of whose work was recorded in the report for 1937 and initial progress in that for 1938. The writer was away on leave from June 12th to September 16th, during which period Mr. C. A. de Silva, Assistant Botanist, supervised his work.

Staff

(*a*) *Rubber Instructors.*—The Department continued to be represented by six Rubber Instructors under the writer's supervision. They were stationed as follows :—

Horana range (Station Horana)	... Mr. H. K. Wijeyesinghe
Matugama range (Station Matugama)	... Mr. B. D. Pedrick
Galle range (Station Poddala) ...	... Mr. N. T. M. C. de Silva
Kandy range (Station Katugastota)	... Mr. H. P. G. Peiris
Ratnapura range (Station Ratnapura)	... Mr. L. A. Peiris
Kelani Valley range (Station Ruanwella)	Mr. H. B. Wijesundara

The above ranges cover practically all the main Rubber districts of Ceylon except Uva and, although some of the individual ranges are large enough for more than one Instructor, the arrangement is working satisfactorily at present. Later, when work expands and more intensive activity in localised areas is called for, more Instructors may be found to be necessary. Advisory work was extended during the year to new areas in some of the ranges, notably the Totamune, Hanwella, Matara, Teldeniya and Gampola areas.

Instructors were paid an enhanced travel allowance during the year, which has enabled them to use motor cycles or Austin 7 cars instead of bicycles for their travelling and thereby do more and better work. Experience has clearly confirmed the advisability of this measure. By the aid of a scheme for obtaining advances from the Board, two small cars and three motor cycles were purchased by Instructors. The average monthly travelling done by an Instructor was approximately 450 miles.

In most ranges the " Rubber Instructor " is now a recognised personality among small Rubber owners and his assistance and advice are freely sought and given. The extent to which this has been done can be gauged to some extent by referring to the " summary of work " appended to this report, which indicates, among other things, the number of private smokehouses built according to standard pattern and areas replanted, under the Instructors' supervision.

Mr. H. B. Wijesundara who was appointed Rubber Instructor, Ruanwella, at the end of 1938 was given the usual course of training under the Rubber Research Scheme at the beginning of this year.

(*b*) *Clerk and Translator.*—Mr. A. A. Silva who continued to hold this office attended to the clerical, translation and accounting work in the office. The

former was considerably increased as a result of the Department taking over the issue of planting material to smallholders.

Tapping

There was comparatively little tapping among smallholders during the year until, with the outbreak of war in September and the attendant steady rise in prices, a considerable increase followed. Towards the end of November practically every smallholder was tapping. Smallholders, the majority of whom dispose of their coupons soon after they get them, do not find it profitable to tap unless the prices of *uncouponed* rubber is at least over 6 cents per lb. The price of uncouponed rubber in the provinces was as low as 4-6 cents a lb. in the first and second quarters of the year, but (from September) rose to 32-35 cents a lb. in December. At a time when Ceylon was finding temporary difficulty in producing her increased exportable maximum and large estates were unable to harvest their full crop owing to interference from the unusually wet weather, the increased tapping among smallholders during the last quarter was both fortunate and helpful.

Every effort was made by the Rubber Instructors to improve the standard of tapping on smallholdings both by means of practical demonstrations and visits to holdings. A total of 94 demonstrations where the tree is marked and tapped by the Instructor showing the correct angle, depth, bark consumption, etc., was given in the six ranges. The competitions that are being held have also been very helpful in improving tapping conditions. A general improvement in tapping will necessarily be a slow and gradual process especially on account of the already badly damaged state of the bark on a large percentage of the holdings, but experience on holdings where virgin bark or new cuts are being opened shows that the importance of better tapping is being increasingly realised if the killing of the goose that lays the golden egg is to be avoided.

Sheet Making

There is much room for improvement in the quality of sheet produced by small owners, and undesirable practices such as the rolling of sheet on the high road still continue to an unpardonable extent. A total of 54 sheet making demonstrations was given in the ranges, where the actual process of making a good sheet is gone through in the presence of groups of smallholders up to the stage when the rolled coagulum is put into the smokehouse. All details are carefully explained. Demonstrations are followed up by visits to those who are interested in improving their sheet. Further efforts for improving sheet were made by the distribution of the Department's leaflet (No. S.H.3) on sheet making for which there was a good demand, by the construction of properly designed smokehouses, and by the publication of a handbill entitled " Dirt in Rubber," which warned smallholders of the results of impurities in their rubber and briefly outlined the necessary precautions for making good, clean sheet. Arrangements were made with the Rubber Controller to have a copy of this handbill handed to every smallholder in the Island with the first issue of coupons for 1940.

Coagulants

The benefit derived by smallholders by the rise in rubber prices was to some extent offset by the shortage of formic and acetic acid which also followed the outbreak of war. Not only did the price of these coagulants rise to unprecedented heights but in most places hardly any supplies at all were available to small buyers. Various impure acids and mixtures of very poor strength were sold by local dealers to unsuspecting smallholders at excessive rates and efforts made by Government to control prices had very little effect. Tests were carried out and suitable locally obtainable substitutes, with instructions on their preparation and use, were recommended through the Instructors and the Sinhalese and English press. Among the emergency coagulants recommended for temporary use were vinegar, sugar, lime-juice and various fruit extracts like Goraka and Kamaranga.

Samples of acid purchased by Instructors from different dealers in the Ruwanwella and Kandy ranges were tested by the Chemist. Out of 16 samples examined one was found to be acetic acid sold as formic and at the price of formic, one possessed a very strong reducing action suggesting contamination with some foreign substance, and one was diluted with about 10% water. The remainder were normal samples of acetic or formic acid. Dealers selling bad acid were written to and warned. The percentage of corrupt samples to normal, as revealed by these tests, however, do not, in the writer's opinion, necessarily indicate the actual extent to which corruption is prevalent, as dealers take good care not to sell to Instructors, who are well-known in their ranges, anything of a suspicious nature.

Smokehouses

A very large percentage of smallholders' smokehouses are ill-designed, badly kept and lacking in ventilation. An equally large or larger percentage (of the poorer ones) do not possess smokehouses at all and smoke their sheet either in their kitchen or in the nearest available smokehouse for payment in money or kind (sheet), both of which practices are not very satisfactory and tend to the production of unclean sheet. The Department has, therefore, endeavoured both to improve existing houses and to get small owners to put up cheap houses of similar model to those specially designed by the Department for the purpose. The building of 83 such houses was started during the year by private owners under the Instructors' supervision; of these 48 were completed. The lining for these houses is done personally by the Instructors. Fourteen existing houses were improved. In addition, 19 demonstration houses in new areas were started at the expense of the Department, of which eight were completed. Considering the low price of uncouponed rubber that prevailed during the greater part of the year and the customary slowness with which smallholders set about such undertakings, the progress made by the Instructors in the construction of these houses may be regarded as very satisfactory.

Replanting

(*a*) *General.*—Small owners, particularly those who have no new land to plant, have begun to realise the opportunities afforded by replanting for replacing some of their poorly grown and badly tapped Rubber with high-yielding material without any loss in their coupon assessments in respect of the Rubber felled. Accordingly the free services rendered by the Instructors, both in supervising all field operations connected with replanting and in contour-lining holdings with their road tracers for holes and drains, have been much in demand. A large number of holdings that were being replanted were visited by the writer in each range during circuit and in practically every case the work was of a very satisfactory standard. As the summary at the end of this report shows, replanting work was carried out under the Instructors' supervision on a total of 128 holdings (174 acres), out of which 120 (158 acres) were lined personally by the Instructors for contour drains or holes or both, and work was completed (*i.e.* budded stumps or seedlings for budding actually planted) on 87 (106 acres). Although the total acreage is not large due to the fact that most replanting areas vary from only quarter to two acres in extent, the number of holdings reveals quite appreciable progress for one year. There was a noticeable slackening in replanting activity during the last quarter due to the reluctance of owners to cut down mature Rubber whose latex was fetching such good prices since the outbreak of war.

In view of the food crop campaign the growing of food crops on replanted lands was encouraged provided an area of 4 ft. round Rubber plants was kept clear and the more exhaustive crops like banana were excluded.

Instructors also assisted numbers of small owners in preparing applications and returns in connection with obtaining permission for replanting, procuring planting material, etc., which present no little difficulty to certain classes.

There was a considerable demand for the leaflet on replanting (No. S.H. 1) issued by the Department.

(*b*) *Demonstrational.*—The seven demonstration replanted blocks in the six ranges were manured with cattle manure, weeded and maintained in good order. Dead plants, " runts " and dormant plants were supplied. An excellent cover has been established on most blocks. The growth in the Ruwanwella block has been retarded due to neglect by the owner to weed and maintain it properly for some time, but this has since been rectified, thanks to the co-operation of the local Ratemahatmaya. Measurements taken at all blocks of the average girth of the plants at 3 ft. are as follows, and, so far, compare very favourably with similar measurements on average estates, in spite of the fact that the plants have had no fertiliser other than cattle manure and compost.

Block	Date planted	No. of plants and clone	Average girth per plant
At Kahatapitiya*	... 29.10.37	... 76 of Tj. 1	... 4.04 ins. on 4. 9.39
At Ratmalgoda*	... 1.11.37	... 116 of PB. 25	... 2.53 ins. on 5. 9.39
At Matugama ,..	... 3. 6.38	... 56 of R.R.A. 18 of B.D. 5	... 4.26 ins. on 14.12.39
At Ruwanwella	... 10.12.38	... 52 of Tj. 16	... 1.25 ins. on 21.12.39
At Baddegama...	... 30.11.38	... 79 of PB. 86	... 3.11 ins. on 1.12.39
At Galagedera...	... 15.12.38	... 77 of PB. 25	... 2.68 ins. on 14.12.39
At Ratnapura ...	... 11.12.38	... 76 of Tj. 1	... 4.61 ins. on 15. 1.40

*Horana range

The effect of the owners' neglect to weed and properly maintain the blocks at Ruwanwella as well as at Galagedera and Ratmalgoda (reported in 1938) is clearly shown by the above figures.

New Planting

The field staff of the New Rubber Planting Scheme (42 officers) was given a special course of training in the work that they were shortly to undertake.

In addition to lining done in connection with replanting, Rubber Instructors lined 47 (134 acres) new planting blocks pending the arrival of the above staff. This work was confined to areas that had already been felled and cleared and where delay to cut drains might have resulted in the loss of valuable soil.

Nurseries

All demonstration nurseries (total 28) were manured, weeded and maintained in proper condition. Budding (with approved clones) for purposes of demonstration to smallholders was started in the nurseries (total 11) in the Horana and Matugama ranges. Each nursery is divided into two and on one half the Instructor demonstrates budding, using good budwood of the particular clone allotted to that nursery. On the other half, a few plants are assigned to each learner to practice budding with ordinary budwood. The latter are destroyed after the first examination, but the plants budded by the Instructors are kept for sale as budded stumps to small owners in the vicinity. Arrangements were made for keeping proper records of the budding done and issues made at each nursery. Four new demonstration nurseries were opened in new areas. Nineteen private nurseries were opened under the Instructors' advice.

Planting Material

The issue of Rubber Research Scheme planting material was confined to smallholders during the year and a good deal of office time was taken up by its allocation and issue. A total of 26,700 stumps and 1,370 yards of budwood was allocated, of which 16,926 stumps and 936 yards were issued. The balance was cancelled due to non-payment and other reasons. Repeated re-allocations necessitated by cancellations took up much unnecessary time and correspondence,

but there appear to be various valid reasons for non-payment such as the inability of smallholders to get planting permits in time, and the difficulty seems to be one which is unavoidable in dealing with the smaller classes of buyers. Of the above issues 7,537 stumps and 591 yards of budwood were made for South-west planting and 9,189 stumps and 345 yards for North-east planting.

Material available for 1940 delivery was advertised in the press, and special application forms and particulars of sale forwarded to applicants.

Competitions

Handbills were issued and entries closed in respect of a competition for the " best-kept holding " in each of the six ranges. Full particulars of the allocation of marks in judging, etc., were explained in the handbill. The first round of visits to competitors was paid by all Instructors, in the course of which the work that was required to be done was explained and, where necessary, demonstrated, and small quantities of cover crop seed were distributed free. The competition is to last for one year, from July, 1939, to July, 1940.

Prizes were distributed by the Director in March to the winners of the two competitions in the Horana range which were held during 1938. Besides the cash and useful rubber utensils given as prizes, certificates of merit were awarded to competitors who reached a required standard. An address in Sinhalese on the progress of smallholdings work was given by the writer on this occasion.

Compost

The preparation of compost by smallholders by accumulating cattle manure, leaf cuttings and other waste material in shallow pits and turning them periodically was encouraged. Thirteen demonstration pits, which serve as examples, were opened at various centres in the ranges and maintained by the Instructors. Private owners opened 121 similar pits. Small owners are taking kindly to this idea in certain districts, but are somewhat slack about turning the heaps at the required intervals.

Training in Budding

Four courses of instruction in budding, each lasting ten days, were given to smallholders by the Budding Instructor at Nivitigalakele. A total of 42 learners attended these courses. A certificate is issued to those who obtain satisfactory results in their test budding.

Forestry Block

The belts of wild plants in the experimental forestry block at Horawala (Matugama) were manured with a light dressing of compost and tall plants lopped to 2 ft. to encourage branching. Growth of these plants has increased during the year, but has not yet reached the ideal.

Poster

Final proofs of the coloured poster for the Department were corrected and approved and the poster will be ready for issue in January, 1940.

Demonstrations

Apart from the demonstrations mentioned under various headings in this eport, 83 budding, 46 disease treatment and 249 other demonstrations (see ummary) were given by Instructors. Other demonstrations include all those hat do not appear under a separate heading in the summary and consist of lemonstrations in planting budded stumps, cutting contour bunded drains, ompost making, manuring, making of grafting tape, preparation of germination eds and various other subjects.

Correspondence

The correspondence for the year, including the period during which the vriter was on leave when correspondence was attended to by the Assistant Botanist, was as follows :—

Inward	1,558
Outward	1,386

General

Visits of inspection were paid to the Galle, Kandy, Ratnapura and Ruwanvella ranges about once in two months and to the Horana and Matugama anges more often. The Horana and Kandy ranges were also inspected by he Smallholdings Committee. The writer served as a member of the Smallholdings Committee and attended one meeting thereof at which the work of he Department was reviewed.

The range maps kept by the Rubber Instructors were marked to show the ocation of demonstrational and other work done in each range and tabled at he Board Meeting in October.

The keeping by Instructors of registers of holdings visited, showing names of owners and dates visited, was started in May. Every Instructor submitted a monthly report of his work and an extract of his diary each week, besides other necessary records and accounts.

(Sgd.) W. I. PIERIS,
Smallholdings Propaganda Officer.

Smallholdings Department,
Nivitigalakele, Matugama.
20th January, 1940.

D=Demonstrational.
O=Other

Summary of Work

Instructor	DEMONSTRATIONS					SMOKEHOUSES			HOLDINGS REPLANTED		Holdings lined for New Planting	Nurseries	Compost pits	Other Main Work
	Sheet-making	Budding	Marking & Tapping	Disease Treatment	Other	Started	Completed	Improved	Started	Completed				
1. Rubber Instructor, Horana	10	25	38	2	83	9 (O) 3 (D)	7 (O) 3 (D)	1 (O)	26 (O) (32 Acs)	19 (O) (18 Acs)	12 (27 Acs)	11 (O)	7 (O) 2 (D)	4 holdings budded (7 acs.) 3 nurseries budded. 3 holdings contour drained. 10 replanting permits obtained. 581 plants budded in dem. nurseries.
2. Rubber Instructor, Matugama	11	20	11	11	43	9 (O) 2 (D)	8 (O) 1 (D)	7 (O)	14 (O) (21¾ Acs)	12 (O) (13¾ Acs)	6 (29¼ Acs)	1 (O)	11 (O) 2 (D)	60 plants budded. 348 plants budded in demonstration nurseries.
3. Rubber Instructor, Galle	11	17	17	11	44	27 (O) 6 (D)	17 (O) 2 (D)	4 (O)	20 (O) (17¾ Acs)	15 (O) (13¼ Acs)	2 (2¾ Acs)	1 (D)	10 (O) 4 (D)	2 holdings budded. 4 holdings lined for drains (4¾ acs.) 2,125 budded stumps ordered. 43 replanting applications filled.
4. Rubber Instructor, Katugastota	11	5	11	5	18	17 (O) 4 (D)	6 (O)	1 (O)	29 (O) (38¼ Acs)	18 (O) (19 Acs)	1 (2 Acs)	1 (O) 1 (D)	80 (O) 2 (D)	2 holdings budded (95 plants.) 8 holdings lined for drains (9¾ acs.). 24 replanting applications filled.
C. forward ...	43	67	77	29	188	62 O) 15 (D)	38 (O) 6 (D)	13 (O)	89 (O) [illegible]	64 (O) [illegible]	21 [illegible]	13 (O) [illegible]	108 (O) [illegible]	

D = Demonstrational.
O = Other.

Summary of Work—(*Contd.*)

Instructor	DEMONSTRATIONS					SMOKEHOUSES			HOLDINGS REPLANTED		Holdings lined for New Planting	Nurseries	Compost pits	Other Main Work
	Sheet-making	Budding	Marking and Tapping	Disease Treatment	Other	Started	Completed	Improved	Started	Completed				
B. forward ...	43	67	77	29	188	62 (O) 15 (D)	38 (O) 6 (D)	13 (O)	89 (O) 109¾	64 (O) (64 Acs)	21 (61 Acs)	13 (O) 2 (D)	108 (O) 10 (D)	
5. Rubber Instructor, Ratnapura	4	11	7	15	37	9 (O) 1 (D)	4 (O) 1 (D)	1 (O)	8 (O) (19½ Acs)	4 (O) (12 Acs)	18 (38 Acs)	3 (O)	5 (O)	4 holdings lined for drains (12½ acs.). 176 plants budded. 101 forms filled.
6. Rubber Instructor, Ruwanwella	7	5	10	2	24	12 (O) 3 (D)	6 (O) 1 (D)		31 (O) (45¾ Acs)	19 (O) (30¼ Acs)	8 (35 Acs)	3 (O) 3 (D)	8 (O) 3 (D)	2 holdings budded (3 acs.). 18 holdings improved by clearing and draining.
						83 (O) 19 (D)	48 (O) 8 (D)					19 (O) 5 (D)	121 (O) 13 (D)	
Total ...	54	83	94	46	249	102	56	14 (O)	128 (O) (174½ Acs)	87 (O) (106¼ Acs)	47 (134 Acs)	24	134	

Acreage Statement and Census

No. of Field	Date of Planting	Acreage	No. of Immature Trees	No. of Mature Trees	Total	No. of Trees per Acre
Mature Areas—						
1	1910	29·2·15	49	2,894	2,943	98
2	1913	0·3·36	—	75	75	75
3	1917	30·2·04	—	2,889	2,889	94
4	1911	1·1·03	—	174	174	140
6	1913	58·2·10	—	5,508	5,508	94
Total		120·3·28	49	11,540	11,589	96
Replanted Areas—						
1	1934	7·3·07	831	—	831	111
2	1938	12·2·10	1,395	—	1,395	111
2*a*	1938	6·2·35	800	—	800	123
3	1936	9·1·10	1,226	—	1,226	129
4	1939	2·0·00	222	—	222	111
Total		38·1·22	4,474	—	4,474	116
Total Rubber		159·1·10	4,523	11,540	16,063	101
Buildings and Roads		14·3·08				
Scrub, etc.		2·2·19				
Grand Total		176·2·37				

Rainfall.—175·21 inches.

Rainfall was over the average. The distribution was abnormal and was characterised by periods of extreme wet and dry weather. A phenomenal downpour occurred on 9th August resulting in a rainfall of 21·03 inches in 24 hours. Details of rainfall during 1939 and the preceding year appear below:—

	1938	1939
January	5·70 ins.	6·72 ins.
February	15·07 ,,	3·87 ,,
March	11·19 ,,	4·15 ,,
April...	25·52 ,,	10·69 ,,
May ...	12·76 ,,	25·17 ,,
Carried over	70·24 ,,	50·60 ,,

ought forward	70·24 ins. ...	50·60 ins.
June	8·47 ,, ...	17·99 ,,
July	11·00 ,, ...	9·73 ,,
August	11·47 ,, ...	27·89 ,,
September	21·27 ,, ...	14·05 ,,
October	7·01 ,, ...	26·40 ,,
November	6·73 ,, ...	21·68 ,,
December	15·66 ,, ...	6·87 ,,
Total ...	151·85 ins.	175·21 ins.

Crop.—Crop for the year amounted to 64,476 lbs. against an estimate of ,000 lbs., which represents a shortage of 7,524 lbs. The shortage may be ributed partly to the abnormal distribution of rainfall and partly to the effects Oidium.

Comparative yield records for individual fields are as follows :—

Field No.	Total Crop lbs.	Acreage Tapped	Yield per Acre lbs.
1 ...	14,512 ...	27½ ...	527·7
2 ...	767 ...	1 ...	767·0
3 ...	16,449 ...	30½ ...	539·3
4 ...	1,017 ...	1½ ...	678·0
6 ...	31,731 ...	58½ ...	542·4
Total ...	64,476	119	541·8

Percentage of estimate harvested : 89·55% .

Crop figures for the Forestry Area, which forms part of Field No. 1, are follows :—

	1938	1939
January-June	5,009 lbs. ...	4,852 lbs.
July-December	7,404 ,, ...	7,457 ,,
Total ...	12,413 lbs.	12,309 lbs.

Tapping.—Tapping remained on the double-four system. Bark consumption averaged 3¼ ins. on each cut.

The tapping in experimental areas was under the supervision of the writer s in former years.

Analysis of Tapping Rounds

(Figures for 1938 are shown in brackets)

	Early tapping	Late Tapping before 10 a.m.	Very Late Tapping	Partial Washout	Washout	No Tapping due to		
						Rain	Rest	Holidays
January ...	26 (28)	2 (1)	—	—	—	1 (—)	—	2 (2)
February ...	6 (11)	— (1)	— (1)	—	— (1)	— (2)	22 (13)	—
March ...	31 (16)	— (2)	—	—	—	—	— (13)	—
April ...	22 (20)	4 (—)	3 (7)	1 (3)	—	1 (2)	—	— (1)
May ...	19 (22)	2 (1)	3 (2)	4 (2)	— (2)	6 (4)	—	1 (2)
June ...	15 (23)	1 (—)	9 (7)	2 (6)	2	5	—	—
July ...	19 (23)	3 (3)	6 (2)	4 (1)	1 (1)	3 (3)	—	—
August ...	25 (14)	— (1)	3 (11)	1 (2)	—	3 (5)	—	—
September ...	18 (13)	1 (4)	8 (9)	4 (3)	—	3 (4)	—	—
October ...	14 (24)	2 (2)	9 (3)	4 (—)	—	6 (—)	—	— (2)
November ...	19 (27)	1 (2)	5 (1)	1 (1)	2 (1)	5 (—)	—	—
December ...	27 (24)	1 (4)	3 (3)	—	—	—	—	—
	241 (245)	17 (21)	49 (46)	21 (18)	3 (4)	33 (20)	22 (26)	3 (7)

Average intake per tapper

	1938	1939
January...	10·2 lbs. ...	9·0 lbs.
February	8·5 ,, ...	7·0 ,,
March	4·5 ,, ...	3·2 ,,
April	8·5 ,, ...	7·1 ,,
May	8·3 ,, ...	8·4 ,,
June	7·2 ,, ...	7·8 ,,
July	8·6 ,, ...	9·5 ,,
August	8·3 ,, ...	9·2 ,,
September	8·7 ,, ...	7·7 ,,
October	10·6 ,, ...	8·1 ,,
November	7·3 ,, ...	9·1 ,,
December	10·0 ,, ...	11·3 ,,

Tapping in Area Selected for Replanting in 1941.—Heavy tapping was started in an area which is due for replanting in 1941. The trees will be tapped on the " double-three " system until the resting period, and the " double-two " system thereafter.

Determination of Individual Yields.—The yields of individual trees on the estate are being determined for the purpose of selecting suitable mother trees.

Manufacture.—The crop was mainly prepared in the form of crepe. Shipments of ammoniated latex were increased, additional latex being purchased from a neighbouring estate for this purpose. Production of smoked sheet was limited, partly due to market conditions and partly to trials with the sheeting equipment during the year. Details of grades are as follows :—

Grades	lbs.	Percent.	Total
Smoked Sheet, No. 1 ...	8,195 ...	12·71 ...	13·21
,, ,, 2 ...	325 ...	·50 ...	
Latex Crepe, No. 1	29,146 ...	45·20 ...	49·75
,, ,, 2	2,588 ...	4·01 ...	
,, ,, 3	346 ...	·54 ...	
Scrap Crepe, No. 1	4,193 ...	6·50 ...	13·89
,, ,, 2	4,537 ...	7·04 ...	
,, ,, 3	224 ...	·35 ...	
Crumb Rubber	559 ...	·87 ...	23·15
Latex	14,363 ...	22·28 ...	
Latex bought from an outside estate...	5,902		

Machinery.—Machinery and electrical equipment were inspected by Messrs. H. W. Hammond & Co., Consulting Engineers, in February. Motors which were not in regular use were run at frequent intervals according to their recommendations, to prevent damage to insulation by dampness.

Factory machinery was maintained in good order at reasonable cost. The piston of the Lister engine was replaced owing to wear. The cause was attributed to the use of Diesel oil as fuel, and this has been substituted by Diesoline.

Details of fuel consumption are given below :—

	Large Engine (Ruston Hornsby 52-57 H.P.)			Small Engine (Lister 9 H.P.)		
	Hours worked	Diesel Oil gals.	Lubric. Oil gals.	Hours worked	Diesel Oil gals.	Lubric. Oil gals.
1939	2,278	2,667	247¾	1,914	816¼	92¾
Average per hour		1·27	·11		·42	·05
1938	1,908	2,499	174½	1,747	722	53
Average per hour		1·31	·09	—	·41	·03

Pests and Diseases.—Oidium infection was observed at the earliest stages of refoliation, and persisted throughout this period despite dry weather and sulphur dusting. Three complete and two partial rounds of dusting were carried out involving a total application of 17 lbs. sulphur per acre. The treatment was effective in preventing defoliation in the lower parts of the estate, but leaf-fall was rather heavy on the ridges and in patches elsewhere.

Other diseases such as Ustulina and canker were not sufficiently severe to warrant any special attention.

A survey of trees affected by Brown Bast is being carried out in conjunction with the determination of yields of individual trees. The necessary treatment of the affected trees is being undertaken in accordance with the instructions of the Mycologist. Scraping is being limited to one field for the present.

Two cases of *Fomes lignosus* were recorded in the mature area near building sites. Complete eradication of roots from a section of one area was not possible, partly due to the high cost of excavating below the site, and partly to the risk of undermining the foundations of buildings nearby.

A case of *Fomes noxius* was also recorded.

Application of Cargillinium mixture A and a 3% solution of Izal to tapping cuts was carried out in wet weather, as in former years, as protection against bark-rot.

Weeding.—The control of natural covers and selective weeding was carried out as in previous years.

Forestry Area.—The control of both ground and erect covers was carried out according to the requirements of this method of cultivation.

Cultivation.—Manure was broadcast in March at the rate of 400 lbs. per acre in the area scheduled for treatment during the year. The second cycle of regular biennial manuring has now been concluded over the whole estate, except

the area under Forestry methods where only one application has been made. ne manure mixture used was as follows :—

Calcium cyanamide	6 parts
Mineral phosphate	2 parts
Muriate of potash	1 part

Twenty acres set apart for manurial trials received treatment according to perimental requirements.

Cover Crops.—As a result of manuring carried out in recent years, a satis- ctory cover of Pueraria has now been established over the whole estate. The ver was beaten down in areas where the growth was unduly heavy.

Labour.—The labour force of Tamils has been adequate for normal require- ents. There was a good demand for indigenous labour during the year. The rnout in times of difficulty was generally encouraging.

The minimum rates of pay were increased as follows, with effect from April :—

Men	41 cts. to 45 cts. per day
Women	33 „ 36 „ „
Children	24 „ 27 „ „

The general health of the labourers has been good.

Precautions were taken against the risk of a possible outbreak of Malaria ring a prolonged spell of dry weather in February-March. All likely breeding aces of the Anopheles mosquito were oiled, and the drainage improved in low- ing areas.

The Inspecting Medical Officer visited the estate in June and recommended rtain structural alterations to lines. Part of the recommendations received ention, but items involving major improvements will be undertaken during e course of the next two years.

Monthly total of labour on Check-roll

	Tamils	Sinhalese	Total
January	45	51	96
February	47	47	94
March	48	48	96
April	48	47	95
May	49	79	128
June	50	54	104
July	50	40	90
August	50	39	89
September	50	48	98
October	45	48	93
November	45	44	89
December...	37	38	75

Figures for daily out-turn and daily rate of pay are as follows :—

Average daily out-turn	60
Average wages per day	47·1 cts.

Malaria Control.—A small scale trial has been started in collaboratio with the Malaria Control Scheme and Department of Agriculture for selectin varieties of plants which would effectively shade small streams to prevent breed ing of the Anopheles mosquito. Six plants of each of 25 varieties have bee established along both banks of a stream. The initial growth of all but a fe varieties has been slow.

Experimental Areas.—

No. 1 area replanted in 1934	7½ acres
„ 2 „ „ 1935 and 1938	12½ „
„ 2*a* „ „ 1938	6½ „
„ 3 „ „ 1936	9½ „
„ 4 „ „ 1939	2 „

The writer exercised supervision of routine work in the different clearings in accordance with the instructions of the Technical Officers.

Field No. 4.—A block of two acres of mature rubber was replanted unde estate control in conformity with experimental requirements.

The method of opening is a modification of the trench system designe to be of special value for a high initial density of planting. A continuous trenc was cut on the contour 2 ft. by 2 ft., and an extra depth of 1 ft. given where th plants were to be sited. A narrow platform 18 inches wide was cut back int the hill behind each trench and the latter partially filled with the earth from thi cutting.

Cart Roads and Paths.—Cart roads were maintained in reasonably goo order throughout the year. Expenditure on upkeep was relatively heavy owin to repairs necessitated by damage to road surfaces during stormy weather.

Four chains of roadway outside a neighbouring estate factory, on the mai approach road, was metalled and tarred.

Water Supply.—A new well was constructed for augmenting the existin water supply.

Buildings.—A junior staff bungalow was constructed under estate supe vision.

NIVITIGALAKELE EXPERIMENT STATION

Acreage Statement.—

Nivitigalakele Division

1926 Clearing	13 acres
1927 „	17 „
1928 „	31 „
Nurseries, buildings, gardens, etc.	8½ „
Total	69½ acres

Pinnagoda Division—

1935 Clearing	28½ acres
1939 ,, ...	10 ,,
Budwood Multiplication Nursery	6½ ,,
1935 Seedling Nursery	1 ,,
1936 ,, ,, ...	2 ,,
Food Crops	3 ,,
Uncultivated	49 ,,
Total ...	100 acres

Rainfall.—167·88 inches.

Crop.—Crop harvested for the year amounted to 20,198 lbs. compared th an estimate of 22,000 lbs., which represents a shortage of 1,802 lbs. 76% the crop was derived from areas in commercial tapping and the remainder m areas in test-tapping. The following is a summary of yield records for ch field :—

	*Approx. Acreage in Tapping	Crop lbs.	Yield per Acre lbs.
1926 Clearing	12¾ ...	6,017 ...	471·9
1927 ,, ...	14¾ ...	6,876 ...	466·1
1928 ,, ...	19¾ ...	7,189 ...	364·0
1935 ,, ...	¾ ...	116 ...	154·7
Total ...	48	20,198	420·8

*These figures constitute only part of the total acreage.

In response to an application for a special assessment the area was inspected an Assessor appointed by the Rubber Controller, and the standard assessment as increased from 29,296 lbs. to 38,536 lbs.

Tapping.—Tapping was carried out in accordance with the requirements the Botanical Department. Details of trees in tapping, etc., during the year e as follows :—

Field and Clearing	Test Tapping	Commercial Tapping	Immature and/or not in Tapping	Total
acres, 1926 Clearing ...	147 ...	1,029 ...	252 ...	1,428
,, 1927 ,, ...	72 ...	1,384 ...	281 ...	1,737
,, 1928 ,, ...	1,002 ...	1,008 ...	736 ...	2,746
acres	1,221	3,421	1,269	5,911

Manufacture.—Crop from commercially tapped areas was manufactured in the form of Smoked Sheet. Test-tapping samples were milled at Dartonfield and sold as scrap crepe. The distribution of grades is as follows :—

Grades	Lbs.	Per cent.	Total
Smoked Sheet No. 1	13,159 ...	65·15	
,, ,, 2	887 ...	4·39 ...	69·79
,, ,, 3	50 ...	·25	
Scrap Crepe No. 1 (mainly test-tapping samples) ...	5,596 ...	27·70	
Scrap Crepe No. 2	506 ...	2·51 ...	30·21

Pests and Diseases.—Although Oidium infection has been less severe than on neighbouring estates, the disease was more active than in any previous year and caused appreciable loss of leaf in certain areas. Four complete rounds and one partial round of dusting were carried out, involving a total application of 15 lbs. sulphur per acre.

Manuring.—Manuring of the Nivitigalakele division Rubber was completed in October and consisted of the application of the following fertiliser mixture at 200 lbs. per acre :—

Calcium cyanamide	6 parts
Bone meal	1 part
Mineral phosphate	2 parts
Muriate of potash	1 part

The manure was broadcast between the contours in areas where the growth of ground cover was good, and lightly dibbled in where the cover was sparse. In steep areas manuring was restricted to the platforms only.

Cover Crop.—Rooted cuttings of *Desmodium ovalifolium* were planted out in the 1926 clearing with a view to establishing it as a permanent ground cover in this area. There is evidence already that the cover will be more suitable than other varieties which have been tried out previously.

Instruction in Budgrafting.—Fourteen courses of instruction in budgrafting were held for learners during the course of the year. One hundred and fifty-five students attended.

Buildings.—A Field Laboratory for the Geneticist was constructed under estate supervision.

PINNAGODA DIVISION

1935 Clearing—28 Acres—

Cultivation.—The plants in this clearing were manured with a complete fertiliser mixture according to schedule.

Thirty-eight blocks, comprising the clones planted as budded stumps, which were allotted to a compost experiment, were manured twice during the year according to experimental requirements.

Disease.—A case of *Fomes noxius* was reported and is the first instance of root disease recorded in this area.

1939 Kosgahahena Clearing—10 Acres.—An area of ten acres jungle nd was cleared and planted according to experimental requirements. A brief utline of the general procedure adopted is given below.

Felling and clearing was completed after some preliminary delay owing to nterference by rain. Owing to the steepness of the land it was essential to ake early precautions to prevent losses by soil erosion. In view of this, the utting of drains received primary attention in the sequence of opening operations nd lining was started as soon as sufficient land was cleared to permit the work o be commenced. Leader drains were defined and a preliminary system of keleton drains, 18 inches wide by 9 inches deep, was cut at intervals of 20 feet t a gradient of 1—120 across the hill, prior to holing. These were later enlarged y an additional 6 inches in width and converted to bunded drains by cutting ilt pits 10 ft. long by 9 ins. deep at intervals of 13 ft. in the drains. Stone terraces ere constructed in rocky parts of the field where difficulty was encountered cutting lateral drains. Rough stone terraces were built about 2·5 feet above e drains, with loose stones collected during excavation, as an additional ecaution against erosion. A contour hedge of *Tephrosia candida* was also anted above the upper side of each lateral drain to provide additional protection ainst wash. A mixture of *Crotalaria anagyroides*, *Centrosema pubescens*, and *alapogonium mucunoides* seed was planted over the whole area.

The efficiency of the drainage system was severely tested by heavy rains xperienced in April and May. The drains functioned satisfactorily in areas here they had been completed and silt pitted. The skeleton drains were oderately effective but, in places, the accumulation of silt led to overflows. There were, however, no serious washaways. Minor overflows also occurred uring the phenomenal storm in August when 18·58 inches fell in 24 hours at Nivitigalakele.

Kosgahahena—1940 Clearing—10 Acres.—Ten acres of land is being pened for planting in 1940, according to the procedure adopted in Malaya for learing jungle land without burning.

Nurseries.—

Budwood Multiplication Nurseries.—The following imported clones were ntroduced for multiplication during the year :—

Rubber Research Institute of Malaya Nos. : 500, 501, 504, 506, 511, 513, 514, 518, 519, 520.

Lunderston N.

1935 1938 Seedling Nursery—1 Acre.— Part of this nursery was used for manurial experiment by the Soil Chemist. A proportion of the plants were udded and removed for sale to smallholders.

1936 Seedling Nursery—2 Acres.—This nursery formed the main source f supply of budded stumps issued during the year. About half the area was eplanted during the seeding season in July/August. A portion of the area

was allotted to a stock experiment and planted with illegitimate seeds of local and foreign clones.

Sale of Budded Stumps and Budwood.—Despatches of budded stumps and budwood were as follows :—

Budded stumps issued to smallholders	16,919
Budded stumps used for experimental planting	1,764
Miscellaneous	331
Budwood issued to smallholders	936 yds.
Budwood issued to Government	2,696 ,,
Budwood issued to Estates	233 ,,

Budding results for the season are as follows :—

	No. Budded	No. Successful	Percentage Successful
January	2,429	2,034	84
February	702	611	87
March	6,132	4,216	69
April	2,784	2,131	61
May	1,881	1,473	78
June	432	527	76
July	1,153	694	60
August	6,524	4,956	76
September	2,811	2,329	83
October	2,142	1,340	62
November	849	477	56
December...	763	534	70
Total ...	28,602	21,122	73·8

The poor results are mainly attributed to the fact that many of the stocks were below the optimum size for budding.

Food Crops.—Three acres of jungle land was cleared for planting in food crops as a war-time emergency.

WAGOLLA

Budded Rubber Area.—Routine visits were paid by the Nivitigalakele Conductor, and inspections were made by the writer in May and December.

Crop amounted to 2,088 lbs. which corresponds to a yield of approximately 11 lbs. per tree. The area was assessed in response to an application for a special assessment and the standard production was increased from 1,684 lbs. to 2,332 lbs.

A cover of *Pueraria phaseoloides* is well established over the whole area.

(Sgd.) D. L. NICOL,
Superintendent.

Dartonfield Estate,
Agalawatta.
24th January, 1940.

EPORT OF THE LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA) FOR 1939

The Committee and Technical Sub-Committee held three meetings during e year. There was also one meeting of the Sub-Committee on Standardisation Raw Rubber appointed in 1937.

The Committee regret to report that Mr. Ian D. Paterson and Mr. F. S. shby, B.Sc., both of whom rendered very valuable service to the Technical b-Committee in recent years, were unable to retain their membership.

Mr. Paterson was transferred for duty with the Goodyear Tyre & Rubber o. in the United States of America and Mr. G. G. Balazs, who has taken his ce in the Company's laboratories at Wolverhampton, is continuing the very ful work started by Mr. Paterson in keeping the activities of the Committee close touch with the requirements of American manufacturers.

Mr. Ashby resigned on retirement from the post of Director of the Imperial cological Institute, and was succeeded by Dr. S. P. Wiltshire, who is now sisting the Committee on mycological problems.

Meetings of the Committee and Sub-Committee were attended by Mr. H. J. ge, Director of the Rubber Research Institute, Malaya, and members of the entific staff, viz., Messrs. C. G. Akhurst, C.E.T. Mann and R. P. N. Napper.

Mr. Page was good enough to place a large amount of his time while on ave in the United Kingdom at the disposal of the Committee and the staff for detailed examination of a variety of matters relating to the work in London d the East. Largely as a result of his efforts a detailed scheme for co-operation tween the British Rubber Producers' Research Association, the Committee d the rubber research organisations in Ceylon and Malaya was agreed with the ssociation. Arrangements were made subsequently for members of the ientific staff of the Committee to attend the monthly staff conferences held the Director of the British Rubber Producers' Research Association at Welwyn.

Following the appointment of Mr. W. S. Davey, B.Sc., senior assistant the staff of the Committee as head of the Chemical Division, Rubber Research stitute, Malaya, Mr. Page reviewed the programme of work in London at the quest of the Committee. He reported that he was satisfied that there was ill ample scope for the employment of a graduate staff of three as hitherto, id for an assistant staff at least as large as at present. On his recommendation, e vacancy arising from Mr. Davey's departure was filled by Mr. W. G. Wren, hose work on roadway problems ceased on 31st May, 1939, owing to the ecision of the British Rubber Producers' Research Association not to continue ie grant previously made for work on this subject.

The Board of the British Rubber Producers' Research Association also cided to discontinue, as from 1st April, 1939, the grant made in recent years or co-operative research with the Limmer & Trinidad Lake Asphalt Co. on

rubber bitumen mixtures for roadways, and, as a result, the services of Mr. T. A. Sharpley had to be terminated by the Committee ; he was, however, given further employment by the British Rubber Producers' Research Association.

Arrangements were made by the Association for work on the subject to be undertaken by the Road Research Laboratories at Harmondsworth and for the experience gained by the staff of the Committee and of the Limmer & Trinidad Lake Asphalt Co. to be utilised in drawing up programmes for further investigations and in reviewing the results obtained.

CO-OPERATION WITH OTHER ORGANISATIONS

Close co-operation was maintained throughout the year with the Research Association of British Rubber Manufacturers whose help in connection with the work of the Standardisation Sub-Committee is of particular value.

Mr. Martin continued to serve on the Committees of the Research Association of British Rubber Manufacturers and of the British Standards Institution and on the Council of the Institution of the Rubber Industry.

Facilities were provided on a number of occasions for members of the staff of the British Rubber Producers' Research Association working in other laboratories in South Kensington to use the heavy rubber machinery in the Committee's workshops.

FINANCE

Contributions of £2,625 and £875 were received from the Rubber Research Institute and the Rubber Research Scheme respectively towards the cost of the work of the Committee during the year 1939. The expenditure incurred amounted to £3,605 19*s.* 1*d.* and after allowing for reserve for plant and for liabilities outstanding, there was an unexpended balance of £1,200 at 31st December, 1939.

ACTION ARISING OUT OF THE WAR

At their first meeting following the outbreak of war the Technical Sub-Committee reviewed the programme of work and it was unanimously agreed that the existing programme should be continued so far as the staff available permits. Minor modifications, however, have been made to meet special applications of rubber to war needs.

The Committee approved a scheme for co-operation with the Research Association of British Rubber Manufacturers in dealing with problems of national importance and referred to the Association by Government Departments and the rubber manufacturing industries. Approval was given to Mr. Martin assisting the Ministry of Economic Warfare in connection with various enquiries on rubber.

The Committee have agreed that any member of the permanent staff called up for service with the Armed Forces of the Crown, whose civil pay exceeded his service emoluments, should be eligible to receive the balance of his civil pay to bring up his total emoluments, civil and service, to the level of his civil pay.

Arrangements were made for suitable laboratory and office accommodation to be available for the Committee in connection with the evacuation scheme for the Imperial Institute, should it be necessary to leave London.

STANDARDISATION OF RAW RUBBER

As indicated in the report for 1938, the work on this subject has been proceeding in two main directions—(1) the preparation of a uniform rubber as measured by physical tests, and (2) the possibility of devising a scheme as suggested by Dr. H. A. Tempany for the identification by an officially recognized mark of rubber from estates adopting an agreed standard of cleanliness in order to meet the complaints from manufacturers that 10% of first grade rubber contains sand in such quantity as to make it unsuitable for use in the manufacture of tubes and other thin articles.

During the year the preliminary work on the preparation of a detailed specification of the procedure to be adopted and the apparatus to be employed in testing rubber for this purpose was completed and copies circulated for comment to (1) the rubber research organisations in Ceylon and Malaya; (2) the International Rubber Research Committee (for the views of corresponding organisations in foreign countries; and (3) to representatives of manufacturers in the U.S.A. and in this country.

In connection with this investigation the Rubber Research Institute, Malaya, and the Rubber Research Scheme, Ceylon, are undertaking the examination of a large number of samples of estate rubber in order to obtain adequate data to enable suitable standards and tolerances to be calculated.

Arising out of the enquiry by the Standardisation Sub-Committee concerning the nature of the mechanical impurities in raw rubber as received at the factory, investigations carried out with the help of Dr. Twiss showed that first grade sheet rubber may contain many particles of sand which are too small to be separated by straining the latex. If the latex is allowed to settle after dilution, however, and then all except the lower layer run off, the rubber obtained is found to be free from sand, but it still contains a small quantity of light impurities such as pieces of bark and seeds, which, being soft, are likely to be dispersed during manufacturing operations.

In view of the fact that the results showed that appropriate action on estates should help in reducing the difficulty experienced by manufacturers owing to the presence of dirt in rubber, the Committee decided to ask the Rubber Growers' Association, the Rubber Research Institute and the Rubber Research Scheme, for their views as to whether a scheme for a recognised mark for clean rubber on the lines suggested by Dr. Tempany would be practicable, and if so, whether it would be of advantage to the rubber growing industry.

INVESTIGATIONS

The object of the investigations in London is to improve the quality of latex and rubber in close collaboration with the rubber research organisations in Ceylon and Malaya. In recent years, owing to improved facilities and equipment becoming available in the East, changes have taken place in the scope of the work undertaken in London, and the investigations carried out under the

auspices of the Committee are now concerned mainly with the development of methods of testing and confirming under European conditions of manufacture, the results obtained in the East on tests with the raw material.

After many years' experience and research, the testing of raw rubber has been proceeding for some time on generally agreed lines, but there is an increasing feeling on the part of some technologists that physical properties which have been ignored hitherto are probably of equal, or even greater, importance than those already studied. Although there is undoubtedly scope for a fundamental investigation of the testing of dry rubber, it has been considered desirable to concentrate on the technique of the testing of latex. With its much shorter history as a commercial product the factors determining its suitability for manufacture are still ill-defined, and testing methods which meet with general approval are not available. The manufacture of articles from preserved latex nearly always involves compounding and coagulation, after which the problems of utilisation are akin to those associated with dry rubber. The behaviour of latex in the presence of compounding ingredients for coagulants depends upon three inherent factors, viz. : (1) the nature and distribution of the rubber hydrocarbon, (2) the nature and concentration of substances constituting the boundary between rubber and serum, and (3) the nature and concentration of the serum solids.

A detailed systematic study is therefore being made to determine the importance of each.

It will be some considerable time before all the aspects of these investigations can be completed, but already it has been ascertained that (1) the relative amounts of soap and protein at the boundary between rubber particle and serum, and (2) the nature and concentration of the serum substances are of importance. Further investigations are proposed to measure these factors by simple tests.

In the work on dry rubber particular attention has been paid to varying methods of preparation with the object of obtaining types of rubber having special properties so as to strengthen the position of the plantation product in meeting increasing competition from synthetic materials. In this connection close co-operation has been maintained with the chemical staffs in Ceylon and Malaya in their work on the preparation of soft rubber and rubber with low water-absorption properties. Tests in the Committee's laboratories have confirmed the widely expressed view that some synthetics prepared in Germany are definitely superior to some types of plantation rubber as far as abrasion is concerned. There is, however, no method generally accepted by rubber technologists for testing abrasion ; the method referred to in the Report for 1938 was found to be less reliable than was expected, but the causes of this have been determined and steps are being taken to improve the test. It is of interest, however, that one sample of rubber prepared by a special method appeared to be superior to others prepared by ordinary estate methods, but no definite conclusions can be drawn until the method of test has been improved.

A list of the reports furnished on these investigations and on others initiated in the Committee's laboratories is given below. Further information as to the investigations completed and in progress during 1939 will be found in the technical appendix to this report.

EPORTS ON INVESTIGATIONS FORWARDED TO CEYLON AND MALAYA DURING 1939

LATEX

esting

(1) Determination of the dry rubber content of latex :—
  (*a*) Comparison of results given by different methods.
  (*b*) Influence of rate of addition of coagulant.
  (*c*) Comparison of results obtained in different laboratories.
(2) Stability tests for latex.
(3) Stability of compounded latex.

olloidal Properties

(1) Distribution of nitrogen by creaming.
(2) Distribution of nitrogen by centrifuging.
(3) Relation between the creaming power of sodium alginate and the viscosity of its solutions.
(4) Comparison of N_r and N_s by creaming and centrifuging.
(5) Changes in the distribution of serum substances in latex on keeping and their relation to stability.
(6) Effect of dilution on the distribution of nitrogen in stored latex.
(7) The relation between N_r and N_s of different latices.
(8) The effect of caustic soda on the distribution of nitrogen in latex.
(9) The effect of soaps.
(10) Accuracy of determinations.

torage

Effect of storage on the properties of latex.
Latex from Ceylon.

reservation

Preservation of latex with sodium pentachlorphenate.

Dried Latex Films

(1) Effect of conditions of storage and accessory substances on the properties of unvulcanised rubber.
(2) Tensile strength of dried latex films.
(3) Reversible dried latex films.
(4) Mechanical properties of dried latex films.

DRY RUBBER

Abrasion

(1) Development of a resistance to abrasion test for comparing different samples of rubber.
(2) The resistance to abrasion of purified rubber.
(3) The resistance to abrasion of special types of rubber.

Purified Rubber

(1) Purified rubber prepared in Java.
(2) Rubber from latex purified by multiple centrifugal creaming.
(3) Purified rubber from West Java.

Standardisation of Rubber

(1) Results of comparative tests by the Goodyear Rubber Co., and the L.A.C. staff using the tentative specification.
(2) Scorching test.
(3) Comparative tests with other laboratories.
(4) Mechanical impurities in sheet rubber.
(5) Co-operative tests with the Research Association of British Rubber Manufacturers.

Softened Rubber

Softened rubber from Malaya.

Miscellaneous Samples

(1) Unsmoked sheet from a Malayan Estate.
(2) Tissue rubber.
(3) Note on the use of paper linings for rubber packing cases.

PATENTS

In conjunction with the British Rubber Producers' Research Association, steps were taken to obtain English patents in connection with the inventions arising out of the work of the staffs in London and the East. As in previous years, the Rubber Research Institute, Malaya, and the Rubber Research Scheme, Ceylon, were supplied with copies of specifications in respect of inventions relating to processes for the preparation or utilisation of raw rubber and latex likely to be of interest to them.

Provisional Specifications Accepted during 1939

13944/39 Compounding latex.
22153/39 Peptising Agents (communicated by the R.R.I., Malaya).

Provisional Specifications Filed during 1939

31244/39 Captax as Peptising Agent (communicated by the R.R.I., Malaya).
31245/39 Benzoyl Peroxide as Peptising Agent (communicated by the R.R.I., Malaya).

Other Patents in Force at 31st December, 1939

428100 Rubber and Road Tar Mixtures
450222 Hemi-Cellulose Creaming Agent
465226 Organic Liquid Addition to Latex
415133 Organic Colloidal Addition to Latex
476743 Preparation of Chlorinated Rubber
474651 Concentration of Latex by Creaming
476269 Brominated Rubber
476073 Stabilised Cream
484712 Rubber and Cement Mixtures

atents Abandoned during the Year

395774
395775
396880
433303
430935

(Sgd.) P. J. BURGESS,
Chairman.

„ J. A. NELSON,
Secretary.

mperial Institute,
April, 1940.

TECHNICAL APPENDIX TO REPORT OF THE LONDON ADVISORY COMMITTEE, 1939

I. LATEX

As explained in the last report (1938) the object of the investigations on latex is to devise tests for quality and for this purpose the rubber globules, the aqueous serum and the boundary surface between globules and serum are, as far as possible, receiving separate attention. This is an ideal which it is difficult to attain in practice because the phases are to a large extent inter-dependent and an alteration in one is usually responsible for alterations in the others. The results of each investigation can generally be analysed, however, in terms of the three phases and this treatment is applied wherever possible.

Langmuir Trough.—An investigation commenced during the year consisted in an attempt to measure differences in samples with regard to the average diameter of the rubber globules and the average mechanical forces between them using for the purpose a Langmuir trough as modified by Adam and others (The Physics and Chemistry of Surfaces, 2nd Edn., 1938, p. 28). A drop of latex was found to spread rapidly on a clean surface of water, the globules becoming well separated, but remaining in the surface and not penetrating into the bulk of the water. The latex was then spread on water in a trough and the globules pushed together until microscopic observation showed that they touched. On compression there was a tendency for a small proportion of the particles to enter the bulk of the water, but this was avoided by spreading the latex on a solution of sodium alginate. From the area occupied by a given quantity of latex of known dry rubber content, a value was calculated for the average thickness of the rubber film. Since this film appeared to be one particle thick, the value obtained should correspond to the average diameter of the rubber particle as defined by the total volume of the particles divided by the total area of the cross section. A value of 0·8 microns was obtained for a random sample of ammonia-preserved field latex. This value is much higher than that found for two samples by Lucas using ultra-violet light photomicrographs, his average diameter being 0·44 microns (Ind. Eng. Chem., 1938, 30, 146). An examination of a film occupying an area corresponding to an average thickness of 0·44 microns showed that the latex particles were a long way from the position of closest packing, clear spaces being observed between most of the particles. When four samples of latex were examined (prepared from the same parent latex, but differing in concentration of serum substances and rubber and in particle size) the relative thicknesses of the films corresponded with what would be expected from a knowledge of the methods employed to prepare the samples. The use of the Langmuir trough to determine particle size was disappointing in so far as the position of close packing could not be determined with sufficient accuracy for a comparison of normal latices where differences in average particle size are not likely to be large.

A measurement of the surface pressure developed at different compressions of the latex film showed that the relation between pressure and area could be

divided into two portions separated by a region near that corresponding to closest packing. In the first region where the area was large and the pressure relatively small, the pressure was directly proportional to the concentration of serum substances, and an increase in pressure inversely proportional to the decrease in area. It is evident, therefore, that this portion of the curve is mostly due to serum substances. In the second region there was a marked increase in pressure with decrease in area, the surface film was creased and folded, and the pressure developed was undoubtedly partly due to the irregular piling of rubber globules on each other.

The investigation has shown that the Langmuir trough may be useful for obtaining a quantitative estimation of surface-active materials in latex, but is not likely to yield other information concerning quality. Its value cannot be fully determined, however, until more is known about surface-active materials in latex and their relation to variation in properties.

The author is indebted to Professors Adam and Rideal for the interest which they have taken in this investigation.

The Surface of the Rubber Globule.—In the last report particulars were given of a method of determining the amount of nitrogenous substances associated with the rubber in latex, as compared with that in the aqueous phase, by determining the amount of nitrogen in the serum and subtracting it from the total nitrogen in the latex. Prolonged centrifuging is required to obtain a rubber-free serum, but it has now been found that serum from creamed latex gives the same result as that from centrifuged latex. Accordingly the determination of nitrogen (and probably other substances) associated with the rubber globule presents no special difficulty. An independent check on the values determined was obtained by the analyses of crepe from different latices after removal of 98% of the serum substances by repeated creaming, the agreement being excellent.

An examination of samples of centrifuged skim and cream from the same parent latex showed that there was more than twice as much nitrogen associated with the rubber in the skim (0·289%) as in the cream (0·133%), the parent latex being intermediate (0·152%) in this respect. Since the nitrogen is not greatly affected by dilution and there is evidence that all except a small proportion (0·02% calculated on the rubber) is on the surface, the results show that the particles in centrifuged skim are on an average only half the diameter of those in centrifuged cream, on the assumption that the concentration of nitrogen per unit of surface is the same for large and small particles.

A study of the effect of heating latex with caustic alkalies showed that the surface nitrogen slowly passes into the aqueous phase, but there is about 0·02% which remains with the rubber. A temperature of 50° C. is required to enable the reaction to proceed to substantial completion in less than a week, but at 70° C. only one day is required. Caustic potash is not as effective as the same concentration by weight of caustic soda. The purification of latex with caustic alkalies by Pummerer's and similar processes is, of course, well-known, but it

has not been quantitatively demonstrated before that the alkali causes surface nitrogenous substances to pass into the aqueous phase of the liquid latex.

The effect of caustic alkali is undoubtedly due in part to the decomposition of surface protein. A method of removing nitrogenous material from the surface of the rubber globule without chemical decomposition has been discovered in the course of the investigation. When latex is treated with a soap such as potassium or ammonium oleate all the nitrogen except 0·03% (calculated on the rubber) passes into the aqueous phase, the surface nitrogenous material being replaced by soap. This is apparently due to the more surface-active material replacing the less surface-active material at an interface (Adam loc. cit., p. 98).

Since the rubber in ammonia-preserved latex contains about 2% naturally occurring fatty acids (Rhodes, Jour. of R.R.I. 9,238, p. 134) which are likely to be present as ammonium soaps, fresh field latex should contain more protein at the surface of the rubber globules than the latex used for manufacturing purposes. The exact amount is somewhat difficult to estimate, because small quantities of soap replace more protein per unit of soap than larger quantities. The information obtained, however, suggests that there is sufficient ammonium soap in preserved latex to replace at least one-third of the surface protein in fresh latex. This would account for the different behaviours of the two types of latex with respect to acid coagulants and would also explain why Rhodes finds a highly significant correlation between coagulation by zinc oxide and the amount of fatty acid in preserved latex (loc. cit., p. 157). It is concluded that the determination of the fatty acid content of the preserved latex is of importance for controlling the quality of the liquid latex, particularly as in the case of two ammonia-preserved latices it was found that there was a considerable decrease in surface nitrogen over 14 months, an increase in acid value, and a decrease in stability to zinc oxide.

The possibility of preparing purified rubber by treating latex with soap has received attention, but it is found that four or five per cent. of soap (calculated on the rubber) is required to replace all the surface protein and that it is necessary to have a similar proportion in the aqueous phase. The soap cannot be easily removed on a practical scale and the presence of such large quantities confers undesirable properties on the rubber.

From the quantitative decrease in the rubber phase and associated substances when latex is treated with potassium oleate, it is concluded that the soap displaces an unknown substance in addition to protein from the surface of the rubber globule, the amount displaced being directly proportional to the concentration of the soap at the surface. The displacement continues to occur after all the surface nitrogenous substances have been removed and the experiments are being extended to determine whether the unknown material contains phosphorus.

The fact that neither caustic alkali nor soap completely removes the nitrogenous substances associated with the rubber indicates that from 0·02 to 0·04% (calculated on the rubber) is more intimately associated with the rubber than

ıe rest and is probably not on the surface, but distributed throughout the mass. hat a small quantity of nitrogen in rubber is difficult to remove is generally nown to rubber technologists, but it has not been demonstrated before that ıere is probably a difference in distribution of this nitrogenous material as ell as in its chemical composition.

Stability of Latex.—One of the most important properties of latex from ıe industrial point of view is its resistance to coagulation during processing. number of laboratory tests have been devised to enable an estimate of this roperty to be made, but, owing to the variety of conditions under which latex ; used commercially, no one test has so far been wholly satisfactory. The inc oxide stirring test developed a year or two ago in the Committee's labora- ories is still found to be of service but the fact that slight modifications in the onditions of the test alter the order in which a series of latices has been ranged or stability shows that it may sometimes give misleading results.

There is a need, therefore, for a systematic study of the fundamental factors ontrolling the coagulation of preserved latex. Such an investigation is already hand, but it will be some time before sufficient data have been collected to ıable satisfactory means of testing to be suggested. In the meantime, practical sts are being sought which give empirical information concerning coagulation nder given conditions.

In preliminary experiments the coagulation of the latex was brought about ı two ways, viz.: (1) by stirring in the presence of "superfine" silica, (2) by ixing the latex with aluminous cement. There was little agreement between he results of the two tests. Thus latex preserved with sodium pentachlor- henate gave a low stability by the friction test and a high stability with the ement. The cement test was a practical test developed in connection with an ıvestigation on latex-cement mixtures for flooring, but it was decided that oagulation by a less complex system of electrolytes than that provided by luminous cement was desirable.

In a further series of experiments, the latices examined were prepared by reaming and centrifuging from one parent latex, coagulation being brought bout by stirring with finely divided silica or with electrolytes, such as calcium hloride or sodium silicofluoride. The latices were found to arrange them- elves in approximately the same order of stability irrespective of the method f test, but coagulation with sodium silicofluoride gave a better end-point than he other methods. It is interesting to observe that with these latices which aried only in particle size and quantity of serum substances present, there was good correlation between the concentration of nitrogen in the serum and the tability. Other experiments showed that there was good correlation between ubber concentration and stability at the same concentration of serum solids. There was no obvious connection between particle size and stability. As the samples were prepared from the same parent latex it is unlikely that they differed appreciably with regard to the concentration of substances at the interface, although of course there were differences in the amount of surface nitrogen calculated in terms of rubber volume or weight. In these circumstances it is

not surprising that there was no evidence that surface nitrogenous substances were responsible for differences in stability between the samples.

Taking into account the whole of the experiments on latex referred to in this report and also the publications of other workers, it is considered that the surface of rubber globules (*e.g.*, relative proportions of soaps and protein) determine the resistance of the latex to coagulation by electrolytes, but the concentration of coagulating ions is partly dependent upon aqueous serum substances, which are, therefore, also of considerable importance in connection with stability. Consequently further material progress requires the development of a method of measuring surface concentration of substances at the rubber-serum interface and a study of the effect of serum substances on the formation of coagulating ions. A method for the determination of the concentration of surface substances in terms of rubber mass has been developed, but information concerning average particle size is required before the results can be expressed in terms of surface area. Coagulation is a synthesis of complicated phenomena, but it is hoped that this analysis of the factors involved will enable tests for quality to be developed of a fundamental as distinct from an empirical character.

Keeping Properties.—During the past three years observations have been made on the changes which occur when ammonia-preserved field and concentrated latex are kept for some time. Although this examination does not comprise a comprehensive investigation of the changes occurring in latex on keeping, it has yielded information of value in planning a more thorough and systematic study.

Samples of field latex from Malaya preserved with varying quantities of ammonia showed a general small decrease in dry rubber content and alkalinity and a large decrease in stability to the zinc oxide test, over a period of three years. At the end of three years the latices were in a bad condition, being very unstable and containing lumps of coagulum.

Samples of field and creamed latex from Ceylon, which had been stored for two years showed a small decrease in dry rubber content and stability, but no change in alkalinity could be detected. The field latices were originally more stable than the creamed samples, but at the end of two years they had about the same stability. There is evidence that the decrease in stability is partly due to the formation of ammonium soaps which replace the protein at the rubber-serum interface and do not protect the latex against coagulation by zinc oxide as efficiently as proteins. Storage in glass bottles, as compared with tin-plated iron cans, gave no appreciable difference save in colour, the bottle samples having the better colour.

Properties of Dried Latex Films.—Particulars were given in the last report of experiments on the mechanical properties and solubility of unvulcanised dried latex films and attention was called to the difficulty of using such measurements to determine the quality of rubber in latex, chiefly because the variations were found to be dependent upon serum substances and not on the quality of the rubber hydrocarbon and the properties of the rubber were markedly affected

by traces of moisture and by changes which occurred on keeping. This experiment has been in progress for 18 months and has now been brought to a conclusion. The outstanding features of the results are: (1) there is a remarkable decrease in the tensile strength of all samples in the relatively short period of 18 months; (2) at the end of this period nearly all the samples are extremely hard in spite of their poor tensile strength; (3) under favourable conditions the proportion of rubber insoluble in solvents may be over 60%; and (4) on the whole, increased tensile strength, hardness and insolubility are favoured by dry atmosphere, serum substances, and absence of oxygen, the dry atmosphere being the most important factor.

These conclusions, of course, only apply to dried-latex films from ammonia-preserved latex, although previous experiments have shown that crepe from fresh latex becomes very hard on keeping in a dry atmosphere. The results now obtained indicate more clearly than before that extensive changes may occur in the mechanical and chemical structure of raw rubber on keeping for a few months, although, of course, these changes are likely to lose much of their importance when the rubber is masticated and vulcanised. They may, however, be of importance in the manufacture of vulcanised articles direct from latex and are, in any case, worthy of more detailed study in order to obtain a complete picture of the properties of rubber.

The fact that serum substances have a marked effect on the tensile strength of dried-latex films has led to experiments in which the serum substances were replaced by colloidal proteins such as glue and casein, both of which were found to improve markedly the tensile strength of dried films from purified latex.

That complex proteins should have this effect is at first surprising, particularly as it is generally assumed that compounding ingredients do not reinforce latex, but information has now been obtained which indicates a possible explanation. Experiments have shown, for example, that an acidic gel such as silicic acid markedly improves the strength of latex films from normal ammonia-preserved latex. When the latex is treated with a kationic soap and then with silica gel, the dried film has no coherence. Similarly a basic gel such as aluminium hydroxide only reinforces the latex rubber in the presence of a kationic soap or amphoteric protective colloids. The results suggest that good strength is dependent upon a chemical bond between the rubber and non-rubber substances and that this bond hinders the unravelling of the tangled chains of rubber molecules and so leads to increased strength.

Whether the explanation offered is correct or not, the results definitely show that the mechanical properties of dried films are greatly influenced by conditions obtaining at the rubber-serum interface in latex. It follows that further study of the phenomena is of considerable importance in order to be able to compound latex so as to obtain the best technical results. The technique of the investigation is not easy, however, because of the difficulty of avoiding spurious effects due to oxidation and the preparation of satisfactory films free from flaws. In view of the calls on the time of the staff it is proposed therefore to discontinue the investigation for the present.

An interesting development from the above investigation is the observation that normally dried films containing two per cent. saponin completely redisperse to latex when immersed in water for a few minutes, no stirring being required. These reversible films are transparent, but contain about one per cent. moisture when kept in the laboratory and in this condition they remain dispersible for many months. They become irreversible if they are dried further or if they are heated to 70° C. or over or are immersed in water at this temperature or if they are deformed by light pressure or stretching. Purified latex does not give such good reversible films as whole latex. The evidence suggests that serum and saponin together form round each rubber globule in latex a protective film which when air-dry has greater mechanical strength than usual. The dry rubber film in consequence retains a structure consisting of the original latex particles completely surrounded by the protective colloids present. Heat or mechanical treatment is required to cause the caoutchouc phase to break through the rigid non-caoutchouc phase to form a continuous medium. The idea of preparing reversible rubber for commercial use is fascinating, but the present product is too sensitive to have practical application.

II. DRY RUBBER

The investigations on dry rubber have been chiefly concerned with the preparation of grades with special qualities for which there is a demand by manufacturers. The development of practical methods of preparation is chiefly the concern of technologists in the East, but the development of suitable testing methods and confirmatory tests on quality are conveniently carried out in London where close touch can be easily maintained with the views of manufacturers. The special grades of rubber to which attention has been given are : (1) clean and uniform rubber, (2) rubber with improved resistance to abrasion, (3) soft rubber, and (4) rubber with reduced tendency to absorb water from a damp atmosphere.

Standard Rubber.—The problem of preparing clean rubber of uniform quality is one which has been frequently discussed in previous reports, but the technical difficulties involved are complicated and some of them do not admit of an immediate solution. There is evidence, however, that such causes of variability as are beyond control remain constant over long periods. It should be possible therefore to obtain a limited measure of standardisation, which although imperfect, would be preferable to many years of research with no immediate prospect of reaching a definite goal. The work is therefore proceeding on carefully considered lines which appear to offer a practical outcome in the shortest time.

Most of the investigations on the preparation of uniform rubber are naturally carried out in the East. The work in London has been devoted chiefly to the revision of a detailed tentative specification of methods to be employed in the testing of standard rubber. This was complete at the end of the year and the specification is ready for circulation with a view to obtaining suggestions and comments from interested organisations. As far as possible the specification conforms with the methods of test recommended by the British Standards Institution and the Crude Rubber Committee of the American Chemical Society.

In a few particulars different practices are recommended by these organisations and the question of which practice to adopt is difficult to decide as differences in European, American and Tropical conditions make a particular practice convenient in one country and not in another. No decision has yet been reached and suggestions from other organisations are being invited.

Experiments are in progress with the Research Association of British Rubber Manufacturers to ensure that the recommended testing methods will give approximately the same results in both laboratories and to discover how differences between laboratories are likely to arise. This investigation will take some time as each step described in the specification is being subjected to test and retest according to the differences in the results obtained.

The preparation of clean rubber received special attention this year because manufacturers have called attention to its urgency and it was demonstrated that the foreign matter complained of is frequently not due to careless handling or packing of the dry rubber. Experiments in conjunction with the Dunlop Rubber Co. have established that this foreign matter is chiefly sand and that first grade sheet is liable to contain many particles, nearly all of which are so small that they would pass through a latex strainer, but which are sufficiently large to cause difficulty in the manufacture of thin-walled rubber articles such as tubes. It was considered that these particles of sand probably entered the latex during collection and transport, and experiments in conjunction with the Rubber Research Scheme, Ceylon, have now shown that crepe, prepared from diluted latex from which sand has been allowed to settle out, is entirely free from siliceous matter on arrival in London. It is evident, therefore, that there is no technical difficulty in preparing clean rubber and the appropriate steps to implement this finding are under consideration.

Abrasion Resistance.—Properly compounded and vulcanised rubber has a remarkable resistance to abrasion, but in view of the German claim that some synthetic materials are distinctly better, there is a case for exploring the possibility of preparing an improved grade of plantation rubber with increased resistance to abrasion. Investigations were commenced in 1938, and it was then pointed out (Annual Report, 1938) that the first step was to develop a satisfactory test. Tyre manufacturers have undoubtedly acquired a considerable amount of information concerning testing technique, but much of this information is not generally available outside the firms concerned. There is, however, general agreement that although the tests are sufficiently reliable to be useful in indicating results which may be expected in practice, they sometimes give misleading results and that important conclusions should be checked by road trials. It was considered sufficient therefore to devise a test capable of detecting improved types of rubber in the laboratory, in the hope that some of the results would be of sufficient interest and reliability to encourage manufacturers to carry out practical trials.

The chief difficulties in testing rubber for resistance to abrasion are: (1) the sample must be mixed with carbon black and other compounding ingredients under rigidly controlled conditions, which are not easy to obtain on small laboratory rolls, and (2) not only must the vulcanised sample be exposed to abrasive

friction of the required type, but, according to information available, the abrasive particles must not be allowed to cling to the sample. The continuous removal of abraded particles is difficult with the " gummy " type of tread stock in general use.

The problem of the control of mixing conditions on small laboratory rolls has not yet been solved satisfactorily, but mechanical changes in the mixing rolls are being made and should have the desired effect. Most attention has been given so far to a study of the abrasive part of the test, and particularly to the removal of abraded particles. Brushing the sample during test with a revolving wire or bristle brush is the usual practice for " non-gummy " mixtures, but does not remove the abraded particles in the tread mix employed. The difficulty was overcome by supplying a continuous stream of a special grade of sand between the test specimen and the abrasive surface, but the sand was subsequently replaced by carborundum powder to conform with suggestions from manufacturers. Fairly uniform results were obtained at first, but the accuracy of the test quickly deteriorated owing to wear of the abrasive surface, and the difficulty of keeping carborundum powder out of the bearings of the machine. Other methods were then tried, but none proved wholly successful partly due to the heat generated by friction with the sample under test. The removal of abraded particles is stated to be necessary because their presence reduced the loss on abrasion, and therefore gives a misleading favourable result (Lambourn, Trans. I.R.I., 1928, 4, p. 210), but in the course of the investigation the presence of abraded particles was shown to have the opposite effect. This is difficult to understand, but the fact was established by repeated experiments in which the only variation was the removal or non-removal of the abraded particles during test. The necessity for continuously removing particles is therefore in doubt, and it is proposed to discontinue this complication of the test.

Among other factors studied the temperature of the test specimen was found to have an important effect on the results. This is difficult to control owing to heat generated in moving parts of the apparatus and transmitted to the test sample. Attempts are being made to increase the control by measuring the temperature developed in the sample during test.

Because of the above difficulties progress in the comparison of the abrasion resistance to special rubbers has been difficult. Several samples of rubber from different clones have been found to give results similar to those given by ordinary sheet from seedlings, but a sample of purified rubber has given superior results. Four separate experiments on two different samples of the purified rubber have indicated that it is more resistant to abrasion than control sheet, but it is not clear whether this is due to a difference in the degree of vulcanisation, the purified sample vulcanising more slowly than the control, or whether it is inherent in the rubber. The correlation between abrasion loss and modulus is very high (0·80 for 14 pairs of tests) so that the degree of vulcanisation appears to be a likely explanation.

Two manufacturing organisations have also carried out tests on these amples of purified rubber. One is of the opinion that the purified rubber is not superior to standard rubber and has confirmed this conclusion by road tests. The other has obtained preliminary results suggesting that the rubber is superior. The problem is being further studied, but until the proposed modifications of he test are complete and found to be satisfactory little progress can be made in distinguishing between different types of rubber.

Miscellaneous Types of Rubber.—Investigations on softened rubber and rubber with low water absorption properties have been confined to the examina ion of promising samples prepared in the East. Reports have been forwarded for the information of the technical staff concerned.

APPLICATION OF LATEX TO ROAD OR FLOOR SURFACING

This investigation has been proceeding since 1935 and was brought to a lose during the year at the end of May. Throughout the period of the investiga- ion mixtures of latex and aluminous cement have received almost continuous ttention, chiefly because they were the most promising and the reason for their echnical merits was not obvious. The investigation indicated that these mixtures owed their advantages to colloidal hydration products of the cement which formed a rigid and continuous gel structure throughout the mass of the rubber. It was considered, therefore, that other gel-forming materials might give useful products. Of those tried silica gels gave the most promising results, and the short time available for the investigation during the year was therefore devoted to a study of these new mixtures. The silica gel was formed *in situ* in the latex by adding organic silicates which were hydrolised by water to form silica gel. Only a small quantity of the gel was required to give a rigid product suitable for flooring, but before the mixtures could be recommended for commercial exploita- ion many details required attention, such as correct stabilisation of the latex o obtain the most suitable rate of coagulation, treatment with compounding ngredients to cheapen the product, retarding and accelerating the gelling process so as to ensure a hard product within convenient limits of time. It was not possible to develop a composition suitable for commercial exploitation in the ive months available, but laboratory scale trials showed that the new mixes were an improvement over aluminous cement mixtures with regard to colour and the absence of dirt-ingraining, which is an important problem in cement- latex mixtures. Mixtures of silica gel and snow-crete (white Portland cement) were particularly promising.

Although the process was not sufficiently developed for commercial use, laboratory samples and the methods of preparation were shown, at the request of the Director of the British Rubber Producers' Research Association, to three firms interested in latex-cement flooring, but in view of the amount of further

work required no developments have yet been reported. Although the laboratory investigations have now come to an end contact is being continued with the Building Research Association who are maintaining their interest in latex-cement flooring.

(Sgd.) G. MARTIN,
Superintendent of Rubber Investigations.

,, P. J. BURGESS,
Chairman.

Imperial Institute,
April, 1940.

AUDITOR-GENERAL'S REPORT FOR 1939

Audit Office,
Colombo, March 13, 1940.

The Chairman,
Board of Management,
Rubber Research Scheme,
Peradeniya.

Sir,

I have the honour to furnish my report on the audit of the accounts of the Rubber Research Scheme for the year 1939 and to forward the following documents duly certified :—

(*a*) Dartonfield Estate Working Account for the year 1939.
(*b*) Nivitigalakele Experiment Station Working Account for the year 1939.
(*c*) Trading Account of Vulcanised Rubber Products for the year 1939.
(*d*) Income and Expenditure Account for the year 1939.
(*e*) Capital Account and General Balance Sheet as at December 31, 1939.
(*f*) Statement of Receipts and Payments of the Officers' Provident Fund for 1939.

I. INCOME

2. The total income which accrued during the year amounted to Rs. 214,738. It exceeded the estimate of Rs. 177,719 by Rs. 37,019 and the income of the previous year by Rs. 35,337.

3. The following is a comparison between the estimate and the actual income under the different accounts for the year under review :—

	Account	Estimated Rs.	Actual Rs.	Excess Rs.	Shortfall Rs.
1.	Cess Collections	148,400	168,613	20,213	—
2.	Interest	3,725	3,476	—	249
3.	Sale of Publications	400	957	557	—
4.	Profit from Dartonfield Estate ...	19,351	27,537	8,186	—
5.	Profit from Nivitigalakele Experiment Station	4,563	11,900	7,337	—
6.	Sundry Receipts	1,280	1,609	329	—
7.	Identification of clones : Excess of receipts over payments	—	644	644	—
8.	Balance of Vulcanised Products' Trading Account	—	2	2	—
		177,719	214,738	37,268	249
	Deduct Shortfall			249	
	Nett Excess			37,019	

4. The reasons for the variations between the estimate and the actual income are as follows :—

Shortfall :

2. Due to withdrawal of funds from fixed deposit in bank.

Excess :

1. Due to increased export quota.

3. Due to under-estimate.

4 and 5. Due chiefly to the realisation of higher prices for rubber and coupons than anticipated and larger sales of budwood at Nivitigalakele.

6. Due to under-estimate.

7. Due to the excess recoveries on identification of clones not having been estimated for.

5. **Profit from Dartonfield Estate.**—The details of the expenditure incurred and the revenue earned from the Dartonfield Estate are set forth in the Working Account of the Estate. The profit earned for the year under review (Rs. 27,537) exceeds that earned for 1938 (Rs. 18,851) by Rs. 8,686.

6. **Profit from Nivitigalakele Experiment Station.**—The working of the Experiment Station for the year showed a profit of Rs. 11,900 as compared with the profit of Rs. 5,100 earned during the previous year. The details of income earned and the expenditure incurred are set forth in the Experiment Station Working Account.

7. **Identification of Clones.**—The unexpended balance out of the recoveries made from estates in connection with the identification of clones stood at Rs. 571 at December 31, 1938. The total recoveries during the year 1939 amounted to Rs. 2,555 and the expenditure incurred was Rs. 2,482, resulting in an excess of Rs. 644 of receipts over expenditure as at December 31, 1939. This sum has been credited to the income for the year under review, as sanctioned by the Board.

8. **Manufacture of Vulcanised Rubber Products.**—A Trading Account showing the cost of manufacture and the income from the sales of the Vulcanised Rubber Products is attached to this report. The undertaking has resulted in a profit of Rs. 1·85 which is credited to the income for the year under review.

II. EXPENDITURE

9. **Revenue Expenditure.**—The total expenditure on Revenue Account exclusive of the amounts allowed for depreciation of fixed assets, the Passage and Audit Fee Reserves and the Reserve for 1939 contribution to the Staff Provident Fund amounted to Rs. 165,488 as compared with Rs. 142,720 of the previous year. The details of this expenditure are fully set forth in the Income and Expenditure Account. The whole of this expenditure was checked with supporting vouchers and accounts.

10. **Capital Account.**—The expenditure incurred on fixed capital assets during the year amounted to Rs. 21,115 as compared with Rs. 51,969 of the previous year. The details of this expenditure are as follows :—

	Rs. cts.
Land including Development :—	
Dartonfield	1,869 76
Nivitigalakele	3,271 44
Buildings and Lines :—	
Dartonfield—Headquarters	4,278 02
Nivitigalakele—Estate	302 63
Nivitigalakele—Headquarters	1,454 17
Furniture and Fixed Equipment :—	
Dartonfield	1,038 85
Nivitigalakele	772 20
Power and Water Supply :—	
Dartonfield	745 36
Nivitigalakele	37 48
Machinery and Tools :—	
Dartonfield	3,266 45
Laboratory Apparatus	4,079 05
	21,115 41

11. The following is a comparison between the original estimate and the expenditure incurred in respect of the year under review :—

Account	Estimated	Actual	Excess	Supplementary Provision and Re-votes	Saving
	Rs.	Rs.	Rs.	Rs.	Rs.
1. Administration of the Board :					
Travelling Expenses of Members	1,800	1,748	—	—	52
2 A-F. Personal Emoluments of Senior Scientific Staff ...	69,697	69,842	145	250	—
3 A-E. Personal Emoluments of Junior Scientific Staff ...	5,242	5,485	243	616	—
4. Library and Publications :					
A. Library	1,000	1,252	252	—	—
B. Publications	2,500	1,536	—	—	964

Account	Estimated	Actual	Excess	Supplementary Provision and Re-votes	Saving
	Rs.	Rs.	Rs.	Rs.	Rs.
5. Smallholdings Work :					
A-B. Salaries and Rent Allowances of Staff	15,539	15,727	188	200	—
C-D. Travelling and General Expenses	9,478	6,173	—	509	3,305
6. Laboratory :					
A. Equipment and Working Expenses	6,000	5,719	—	—	281
B. Furniture Replacements ...	50	37	—	—	13
7. Field and Factory Experiments :					
A. Field Experiments	3,498	3,848	350	—	—
B. Factory Experiments ...	2,094	2,633	539	—	—
C. Budding Instruction ...	1,060	828	—	—	232
8. Office :					
A-C. Emoluments of Office Staff	8,405	8,407	2	—	—
D. Stationery and Office Equipment	2,500	2,195	—	—	305
E. Postages and Telegrams ...	2,000	1,832	—	—	168
F. Advertising	250	236	—	—	14
G. Telephone	1,000	988	—	—	12
H. Audit...	600	600	—	—	—
9. Travelling Expenses of Staff ...	6,300	4,674	—	—	1,626
10. Maintenance of Buildings, Water and Power Supply :					
A. Laboratories and Offices ...	250	152	—	—	98
B. Bungalows	1,260	1,199	—	—	61
C. Water and Power Supply ...	350	726	376	—	—
11. Miscellaneous Items shared with Estate :					
A. Dartonfield General Charges	5,489	5,381	—	—	108
B. Nivitigalakele General Charges	1,613	1,670	57	150	—

	Account	Estimated	Actual	Excess	Supplementary Provision and Re-votes	Saving
		Rs.	Rs.	Rs.	Rs.	Rs.
C.	Upkeep of Roads and Grounds	517	566	49	—	—
D.	Factory Upkeep	413	459	46	—	—
E.	Power Supply	2,294	2,474	180	—	—
12.	**Contingencies :**					
A.	Contribution to London Advisory Committee ...	12,000	11,748	—	—	252
B.	General Charges	750	585	—	—	165
C.	Insurance Charges	850	972	122	125	—
D.	Staff Provident Fund ...	6,283	13,972	7,689	—	—
E.	Passages	1,000	1,000	—	—	—
F.	Entertainment Allowance ...	300	160	—	—	140
13.	**Depreciation**	23,000	19,474	—	—	3,526
14.	**Capital Account :**					
A.	Dartonfield Junior Staff Bungalow...	4,000	4,004	4	—	—
B.	Extension to Nivitigalakele Conductor's Bungalow ...	315	303	—	—	12
C.	Apparatus for Botanist and Soil Chemist	2,750	4,602	1,852	3,055	
D.	Almirah for Smallholdings Office	75	51	—	—	24
E.	Upkeep of Dartonfield Immature Areas	1,347	1,213	—	90	134
F.	Replanting 2 Acres Dartonfield	340	365	25	76	—
G.	Upkeep of Pinnagoda New Clearing	905	818	—	—	87
H.	Planting 10 Acres Pinnagoda	2,010	2,002	—	—	8
15. A.	Metalling Gallawatta Road...	—	292	292	300	—
B.	Dartonfield Senior Staff Bungalow...	—	641	641	650	—
C.	Field Laboratory for Geneticist	—	1,854	1,854	2,000	—

Account	Estimated	Actual	Excess	Supplementary Provision and Re-votes	Saving
	Rs.	Rs.	Rs.	Rs.	Rs.
D. Junior Staff Bungalow, Nivitigalakele	—	359	359	350	—
E. Experimental Machinery, Dartonfield	—	3,266	3,266	2,435	—
F. Chief Clerk's Bungalow, Dartonfield	—	192	192	200	—
G. Water and Power Scheme ...	—	701	701	1,912	—
I. Pinnagoda Budwood Nurseries	—	405	452	—	—

12. The reasons for the major variations between the estimate and the actual expenditure, as furnished by the acting Director of Research, are as follows :—

Savings :

4B. Lower printing costs and increased revenue from advertisements.
5C-D Smallholdings Propaganda Officer on leave for three months and programme of work not completed.
6A Goods not received from overseas.
7C. No Instructor for one month and new appointment on lower salary.
8D. Economy in purchase of stationery and office requisites.
9. Mycologist on leave for three months and two other officers mobilised in September, 1939.
12A. Difference in exchange.
13. Reduction in depreciation rates.

Excesses :

3A-E. Appointment of an additional laboratory assistant during the year as sanctioned by the Board.
4A. Under-estimate.
7A. Pollination work not provided for in the original estimate.
7B. Boiler repairs and increased cost of latex.
10C. Repairs to water pump and painting storage tank.
11E. Increased consumption of fuel oil.
12D. Transfer of the bonus contribution for 1939 to a " Reserve for bonus contribution to the Provident Fund " in addition to the crediting of the 1938 contribution to the Provident Fund Reserve Account, as sanctioned by the Board.
14C and 15B-F. Re-votes passed by the Board to meet expenses on capital works undertaken during the previous year and completed in 1939.

15A and G. Works undertaken during the year as sanctioned by the Board.

15I. Expenditure not estimated.

13. The excesses under the different items of expenditure except the following have been sanctioned by the Board :—

		Rs. cts.
4A.	Library	251 61
7A.	Field Experiments	350 44
7B.	Factory Experiments	538 66
8A-C.	Emoluments of Office Staff	2 01
10C.	Maintenance of Water and Power Supply	375 68
11C.	Upkeep of Roads and Grounds...	48 76
11D.	Factory Upkeep	46 30
11E.	Power Supply	179 70
12D.	Staff Provident Fund	7,688 80
14A.	Dartonfield Junior Staff Bungalow	4 43
15D.	Nivitigalakele Junior Staff Bungalow	9 07
15E.	Experimental Machinery, Dartonfield	831 45
15I.	Pinnagoda Budwood Nurseries...	451 73

14. **Sale of Fixed Assets.**—The sulphur dusting machine sold during the year realised a sum of Rs. 300, which was reduced from the capital value of the fixed assets and transferred to the Board's surplus. A further sum of Rs. 692·51, being the amount of depreciation set apart from 1935 to 1938 on this machine, was transferred from the Depreciation Reserve Account to the surplus.

III. CAPITAL ACCOUNT

15. The cost of fixed assets at December 31, 1938, stood at Rs. 671,127. The expenditure incurred on capital account during the year amounted to Rs. 21,115 and value of fixed assets sold during the year amounted to Rs. 992, leaving the value of the remaining assets at Rs. 691,250 as on December 31, 1939. The details of this amount are set forth in the Capital Account.

IV. BALANCE SHEET

(*a*) Liabilities

16. **Creditors—Rs. 9,286.**—Of this amount a sum of Rs. 8,971 represents the total amount due to creditors for goods purchased or services rendered in respect of the year and Rs. 315 the subscriptions for 1940 publications received in advance.

17. **Passage Fund Reserve—Rs. 4,614.**—The balance on December 31, 1938, was Rs. 3,614. During the year a sum of Rs. 1,000 has been transferred to this Fund, bringing the balance to Rs. 4,614 as at December 31, 1939.

18. **Depreciation Reserve—Rs. 94,197.**—This sum represents the amount set apart for the depreciation of the fixed assets of the Scheme. During the year, a sum of Rs. 692 representing the amount set apart in respect of apparatus sold was written off and another sum of Rs. 410 was utilised from this fund for the purchase of a new duplicator, as sanctioned by the Board. The amount

transferred from revenue to this account during the year was Rs. 19,474, made up as follows :—

	Rs. cts.
Buildings and Lines :	
Dartonfield at 3½% on Rs. 193,528·65	6,773 50
Nivitigalakele at 3½% on Rs. 44,952·29	1,573 33
Furniture and Fixed Equipment :	
Dartonfield at 7½% on Rs. 25,672·26	1,925 42
Nivitigalakele at 7½% on Rs. 2,268·79	170 16
Water and Power Supply :	
Dartonfield at 7½% on Rs. 29,261·36	2,194 60
Nivitigalakele at 7½% on Rs. 5,197·09	389 78
Machinery and Tools :	
Dartonfield at 7½% on Rs. 69,874·01	5,240 55
Nivitigalakele at 7½% on Rs. 90·27	6 77
Dartonfield Accumulators at 20% on Rs. 3,074·81	614 96
Laboratory Apparatus at 7½% on Rs. 7,799·22	584 94
	19,474 01

19. **Provident Fund Reserve—Rs. 51,686.**—The particulars of the receipts and payments on this account are shown in the Provident Fund Account attached to this report. The balance standing to the credit of this fund at the beginning of the year was Rs. 40,552. The contributions by the staff during the year amounted to Rs. 5,570 and those made from the funds of the Scheme amounted to Rs. 6,235. Of the amount contributed by the Scheme, a sum of Rs. 4,509 represents the bonus equivalent to the sum contributed by the staff during 1938 and Rs. 1,710 the interest due on the fund for 1938. During the year a sum of Rs. 671 was refunded to retiring officers of the Scheme.

20. **Reserve for Bonus Contribution to the Provident Fund—Rs. 7,736.**—This sum represents the Provident Fund bonus contribution and interest due for 1939 from the funds of the Scheme, which was transferred to a Reserve Account pending transfer to the Provident Fund Reserve Account, as sanctioned by the Board in 1939.

21. **Audit Fee Reserve—Rs. 605.**—This amount represents the balance of Rs. 5 out of the reserves for 1937 and 1938 and Rs. 600 being the estimated cost of audit payable in respect of the year under review charged to the income of the year on the directions of the Board of Management. The actual cost of the audit for the year is Rs. 594·39.

22. **Surplus Account—Rs. 133,624.**—This amount represents the accumulated cash surplus of the Scheme at December 31, 1939. The cash surplus at the commencement of the year was Rs. 133,307. The excess of income over expenditure for the year was Rs. 20,440. The net capital expenditure incurred

during the year was Rs. 20,123. There was, therefore, a cash surplus for the year amounting to Rs. 317 which increased the total cash surplus at the close of the year to Rs. 133,624.

(*b*) Assets

23. **Debtors—Rs. 37,484.**—Of this amount, a sum of Rs. 25,398 represents the amount due from the Deputy Financial Secretary on account of Cess collections made during December, 1939. This amount was received from him in January, 1940. The balance Rs. 12,086 was due from various persons in respect of produce, etc., sold and labour lent.

24. **Advance Account—Rs. 1,897.**—The details of the items making up the balance on this account are given in the Balance Sheet. The advances to the Superintendent of Dartonfield and Wagolla Estates and the Smallholdings Propaganda Officer were for sundry expenses and the amount shown against the Postmaster-General represents the amount deposited with him in respect of trunk call and other telephone fees.

25. **Accrued Interest on Investments—Rs. 793.** This sum represents the amount of interest accrued for the year on the investments of the cash balances but not received during the year.

26. **Payments in Advance—Rs. 791.**—This sum represents the amounts paid during 1939 as insurance premiums and subscription charges for publications in respect of 1940 and in connection with expenditure incurred on the Nivitigalakele New Nursery and New Clearing of 1940.

27. **Stock-in-Trade—Rs. 2,876.**—Of this amount, a sum of Rs. 359 represents the value of latex and vulcanised rubber products, Rs. 630 the value of the balance rice in hand, and Rs. 1,887 the value of other stores in hand on December 31, 1939.

28. **Loans for the Purchase of Motor Cars and Cycles—Rs. 1,718 56.**—This amount represents the balance outstanding out of the loans granted to five members of the staff for the purchase of transport. The loans are being repaid in instalments with interest.

29. **Investments in Ceylon Government Loans—Rs. 61,750.**—The stock certificates relating to the Rs. 25,000 Ceylon Government $3\frac{1}{2}\%$ Loan, 1957/62 and the Rs. 75,000 Ceylon Government, $3\frac{1}{4}\%$ Loan, 1949/51 were inspected. The sum of Rs. 25,000 appearing in the Balance Sheet represents the face value of the $3\frac{1}{2}\%$ Loan, whereas the price at which this loan was quoted in the market at December 31, 1939, was 98, at which rate the value of the investment would be Rs. 24,500. The other sum of Rs. 36,750 represents the instalments paid during the year on account of the $3\frac{1}{4}\%$ loan and the balance on this investment was paid to the Ceylon Government in January, 1940.

30. **Cash Balances—Rs. 194,436.**—The receipts in support of the fixed deposits in banks amounting to Rs. 130,000 were inspected and the sum of Rs. 2,000 lying in deposit at the Ceylon Savings Bank was verified by reference to the connected pass book. The balances in current account with the National

Bank of India, Limited, Colombo, were verified by reference to the bank certificates. The balance of cash in hand at December 31, 1939, was not verified, but a surprise verification of the cash in hand was made on February 19, 1940.

V. GENERAL

31. The accounts were received monthly and examined in this office. The office of the Scheme at Dartonfield Estate was visited once during the year and the books and accounts kept were checked and the cash in hand verified.

I am, Sir,
Your Obedient Servant,
(Sgd.) O. E. GOONETILLEKE,
Auditor-General.

RUBBER RESEARCH SCHEME (CEYLON)

Revenue Account for the Year ended 31st December, 1939.

Dr. Cr.

	Rs. cts.	Rs. cts.		Rs. cts.
To Personal Emoluments :—			By Balances from Estate Working Accounts :—	
Senior Scientific Staff	69,841 85		Dartonfield	27,537 13
Junior Scientific Staff	5,485 32		Nivitigalakele	11,899 66
Office Staff	8,407 01	83,734 18	„ Cess Collections	168,612 91
„ Library and Publications :—			„ Interest	3,475 91
Library	1,251 61		„ Sale of Publications	957 05
Publications ...	1,536 47	2,788 08	„ Sundry Receipts	1,609 58
„ Smallholdings Work :—			„ Identification of clones : Excess of Receipts over Payments	643 69
Salaries and Allowances	15,726 91		„ Sale of Vulcanised Products :—	
Travelling and Gen. Expenditure ...	6,173 17	21,900 08	Balance of Trading Account ...	1 85
„ Laboratory :—				
Equipment and Working Expenses	5,719 36			
Furniture Replacements	36 75	5,756 11		
„ Field and Factory Experiments :—				
Field Experiments...	3,848 44			
Factory Experiments	2,632 66			
Budding Instruction	827 63	7,308 73		
„ Office :—				
Stationery and Office Equipment ...	2,194 87			
Postages and Telegrams	1,832 12			
Advertising ...	236 22			
Telephones... ...	988 12			
Audit	600 00	5,851 33		
„ Travelling :—				
Expenses of Board Members... ...	1,747 75			
Expenses of Staff ...	4,674 49	6,422 24		
„ Maintenance of Buildings and Water and Power Supply :—				
Laboratories and Offices	151 89			
Bungalows	1,199 25			
Water and Power Supply	725 68	2,076 82		
„ Miscellaneous Items shared with Estate :—				
Dartonfield General Charges	5,380 51			
Nivitigalakele ...	1,670 16			
Upkeep of Roads and Grounds ...	565 76			
Factory Upkeep ...	459 30			
Power Supply ...	2,473 70	10,549 43		
„ Contingencies :—				
Contribution to London Advisory Committee ...	11,748 34			
General Charges ...	585 14			
Insurances	971 66			
Staff Prov. Fund : Contribution for 1938 Rs. 6,235.43 Reserve for 1939 Contribution Rs. 7,736.37	13,971 80			
Contribution to Passage Fund Reserve	1,000 00			
Entertainment Allowance ...	160 00	28,436 94		
Depreciation ...		19,474 01		
„ Balance being excess of Income over Expenditure for the year carried forward to the Balance Sheet ...		20,439 83		
	Rs.	214,737 78		Rs. 214.737 78

Dartonfield Estate.

Working Account for the Year ended 31st December, 1939.

Dr. Cr.

	Rs. cts.	Rs. cts.		Rs. cts.
To Expenditure :—			By Sale of Rubber (70,378 lbs.) and Coupons	45,764 92
General Charges ...	5,380 52			
Upkeep	774 56			
Cultivation... ...	1,312 77			
Collection	3,250 08			
Manufacture ...	5,744 82			
Distribution ...	1,765 04	18,227 79		
„ Balance transferred to Revenue Account ...		27,537 13		
	Rs.	45,764 92		Rs. 45,764 92

Nivitigalakele Experiment Station

Working Account for the year ended 31st December, 1939.

Dr. Cr.

	Rs. cts.	Rs. cts.			Rs. cts.
To Expenditure :—			By Sale of Produce :		
General Charges ...	1,670 16		Rubber (24,213 lbs.) and Coupons ...	14,025 45	
Upkeep, etc. ...	4,121 37	5,791 53	Planting Material ...	7,669 39	
Upkeep of Nurseries	2,469 86		Cover Crop Seed ...	80 50	21,775 34
Collection and distribution of Budwood and Budded Stumps	1,568 37				
Collection of Cover Crop Seed ...	45 92	4,084 15			
,, Balance transferred to Revenue Account ...		11,899 66			
		21,775 34			Rs. 21,775 34

Manufacture of Vulcanised Products.

Trading Account for the year ended 31st December, 1939.

Dr. Cr.

	Rs. cts.	Rs. cts.		Rs. cts.
To Value of stock in hand on January 1, 1939 :—			By Sales	563 02
Raw Materials ...	850 52		,, Value of Raw Materials transferred to Chemical Department	805 88
Finished Goods ...	572 16	1,422 68	,, Stock of Finished Goods in hand on December 31, 1939 ...	67 13
,, Sundry Charges ...		11 50		
,, Nett Profit		1 85		
	Rs.	1,436 03		Rs. 1,436 03

RUBBER RESEARCH SCHEME (CEYLON)

Capital Account as at 31st December, 1939.

Dr. Cr.

	To December 31st, 1938	Transfers between Accounts	Additions in 1939	Deduct Cost of Assets sold or scrapped in 1939	Total
	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.	Rs. cts.
To Land including Development :—					
Dartonfield	107,692 77	—	1,869 76	—	109,562 53
Nivitigalakele	99,307 68	—	3,271 44	—	102,579 12
„ Buildings and Lines :—					
Dartonfield—					
Estate	33,733 83	—	—	—	33,733 83
Headquarters	178,417 11	—	4,278 02	—	182,695 13
Nivitigalakele—					
Estate	27,712 63	—	302 63	—	28,015 26
Headquarters	20,449 48	—	1,454 17	—	21,903 65
„ Furniture and Fixed Equipment :—					
Dartonfield	32,505 27	—	1,038 85	—	33,544 12
Nivitigalakele	3,463 65	—	772 20	—	4,235 85
„ Power and Water Supply :—					
Dartonfield	33,608 97	—	745 36	—	34,354 33
Nivitigalakele	5,250 10	—	37 48	—	5,287 58
„ Machinery and Tools :—					
Dartonfield	93,779 45	—	3,266 45	—	97,045 90
Nivitigalakele	105 50	—	—	—	105 50
„ Laboratory Apparatus ...	23,767 19	—	4,079 05	992 51	26,853 73
„ London Plant	11,333 34	—	—	—	11,333 34
Rs.	671,126 97	—	21,115 41	992 51	691,249 87

	Rs. cts.	Rs. cts.
By Revenue applied for Capital purposes :—		
At December 31, 1938	671,126 97	
In 1939	20,122 90	
	Rs.	691,249 87

GENERAL BALANCE SHEET AS AT 31st DECEMBER, 1939.

LIABILITIES	Rs. cts.	Rs. cts.
Creditors :—		
Sundries	8,970 58	
Subscription for 1940 publications received in advance	315 00	9,285 58
Passage Fund Reserve :—		
At December 31, 1938	3,613 74	
Add Reserve for 1939	1,000 00	4,613 74
Depreciation Reserve :—		
At December 31, 1938	75,825 20	
Less Nett value of New Duplicator (Rs. 410) and depreciation on apparatus sold (Rs. 692·51)	1,102 51	
	74,722 69	
Add Reserve for 1939	19,474 01	94,196 70
Provident Fund Reserve :—		
At December 31, 1938	40,552 22	
Addition during 1939	11,133 58	51,685 80
Reserve for Bonus Contribution to the Provident Fund		7,736 37
Audit Fee Reserve :—		
At December 31, 1938	604 28	
Add Reserve for 1939	600 00	
	1,204 28	
Less Payments in 1939	599 08	605 20
Surplus Account :—		
At December 31, 1938	133,306 66	
Add Excess of Income over Expenditure in 1939	20,439 83	
	153,746 49	
Less Contribution to Capital Outlay in 1939	20,122 90	133,623 59
Rs.		301,746 98

ASSETS	Rs. cts.	Rs. cts.
Debtors :—		
Cess Collection for December, 1939	25,398 17	
Sundries	12,085 52	37,483 69
Advance Accounts :—		
London Advisory Committee...	1,653 14	
Estate Superintendent—		
Dartonfield ... ... Rs. 21·61		
Wagolla ... ... „ 7·91	29 52	
Smallholdings Propaganda Officer	104 42	
Postmaster-General	110 00	1,897 08
Accrued Interest on Investments		793 52
Payments in Advance		791 42
Stock-in-trade		2,876 49
Loans for purchase of Motor Cars and Cycles...		1,718 56
Investments :—		
In Ceylon Government 3½% Loan, 1957/62...	25,000 00	
In Ceylon Government 3¼% Loan, 1949/51...	36,750 00	61,750 00
Cash Balances :—		
At Ceylon Savings Bank	2,000 00	
On Fixed Deposit	130,000 00	
On Current Account, No. 1	61,977 28	
On Current Account, No. 2	263 06	
In Hand	195 88	194,436 22
Rs.		301,746 98

I certify that the above Balance Sheet presents a true and correct view of the financial affairs of the Rubber Research Scheme (Ceylon) as shown by the books on December 31, 1939.

Audit Office,
Colombo, *March 13th, 1940.*

(Sgd.) O. E. GOONETILLEKE,
Auditor-General.

PROVIDENT FUND.

Working Account for the year ended 31st December, 1939.

Dr. Cr.

	Rs. cts.	Rs. cts.	Rs. cts.
To Payments to retiring Officers	671 35	By Balance brought forward from 1938 ...	40,552 22
„ Balance carried forward to 1940	51,685 80	„ Board's Contribution for 1938 :—	
		Bonus	4,509 08
		Interest on Officers' Contributions ...	907 28
		Interest on Bonus	802 76 6,219 12
		„ Members' Contributions in 1939	5,569 50
		„ Bonus and Interest for 1939 paid to two retiring Officers	16 31
Rs.	52,357 15	Rs.	52,357 15

Audit Office,
Colombo, *March 13th, 1940.*

Audited and found correct,
(Sgd.) O. E. GOONETILLEKE,
Auditor-General.

ESTIMATES FOR 1940

(Adopted by the Board, October 12th, 1939)

REVENUE

		Rs. cts.
1.	Cess Collections	180,600 00
2.	Interest	3,000 00
3.	Sale of Publications...	800 00
4.	Profit from Dartonfield	21,805 00
5.	Profit from Nivitigalakele	5,370 00
6.	Sundry Receipts	1,400 00
		Rs. 212,975 00

REVENUE EXPENDITURE

		Rs. cts.	Rs. cts.
1.	**Administration of the Board :**		
	Travelling Expenses of Members		2,000 00
2.	**Personal Emoluments :**		
	Senior Scientific Staff...	72,525 00	
	Junior Scientific Staff...	6,195 00	78,720 00
3.	**Library and Publications :**		
	Library...	1,500 00	
	Publications	1,450 00	2,950 00
4.	**Smallholdings Work :**		
	Salaries and Allowances	16,515 00	
	Travelling and General Expenditure ...	11,019 00	27,534 00
5.	**Laboratory :**		
	Equipment and Working Expenses... ...	6,000 00	
	Furniture Replacements	50 00	6,050 00
6.	**Field and Factory Experiments :**		
	Field Experiments	4,468 00	
	Factory Experiments	1,771 00	
	Budding Instruction	853 00	7,092 00
7.	**Office :**		
	Salaries of Office Staff	8,680 00	
	Stationery and Office Equipment	2,500 00	
	Postages and Telegrams	2,000 00	
	Advertising	200 00	
	Telephone	1,000 00	
	Audit	600 00	14,980 00
8.	**Travelling of Staff**		5,000 00
		Carried over ... Rs.	144,326 00

		Rs. cts.	Rs. cts.
	Brought forward		144,326 00
9.	**Maintenance of Buildings :**		
	Laboratories and Offices	250 00	
	Bungalows	1,000 00	
	Water and Power Supply	400 00	1,650 00
10.	**Miscellaneous Items Shared with Estate :**		
	Dartonfield General Charges...	5,610 00	
	Nivitigalakele General Charges	1,844 00	
	Upkeep of Roads and Grounds	517 00	
	Factory Upkeep	525 00	
	Power Supply	2,535 00	11,031 00
11.	**Contingencies :**		
	Contribution to London Advisory Committee	12,000 00	
	General Charges	750 00	
	Insurance Charges	1,100 00	
	Staff Provident Fund	7,750 00	
	Passages	1,000 00	
	Entertainment Allowance	300 00	22,900 00
12.	**Depreciation**		19,250 00
		Rs.	199,157 00

CAPITAL EXPENDITURE

	Rs. cts.	Rs. cts.
Equipment :		
Storage Tank for Latex		700 00
Immature Areas :		
Dartonfield	1,425 00	
Nivitigalakele	4,597 00	6,022 00
	Rs.	6,722 00

SUMMARY

Income		212,975 00
Expenditure :—		
Revenue	199,157 00	
Capital	6,722 00	205,879 00
Excess of Income over Expenditure	Rs.	7,096 00

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